SCIENTIFIC AMERICAN

No. SUPPLEMENT 143

Scientific American Supplement, Vol. VI., No. 143. | NEW YORK, SEPTEMBER 28, 1878. | Scientific American Supplement, $5 a year.
Scientific American, established 1845. | | Scientific American and Supplement, $7 a year.

PROF. von LENHOSSEK'S IMPROVED POLY-MICROSCOPE.

We owe to the kindness of Professor Joseph von Lenhossek, of the University of Buda Pesth, Hungary, a pamphlet describing an apparatus which he calls a Poly-Microscope. It is an adaptation of the well-known revolving stereoscopic camera to microscopic purposes, and is specially intended to be used in connection with anatomical lectures for demonstrating the gradual formation of organs by a series of successively arranged objects. The apparatus is shown in use and also on an enlarged scale in Figs. 1 to 5, Figs. 6 and 7 showing detail views of the

FIG. 1.—PROF. von LENHOSSEK'S MICROSCOPE.

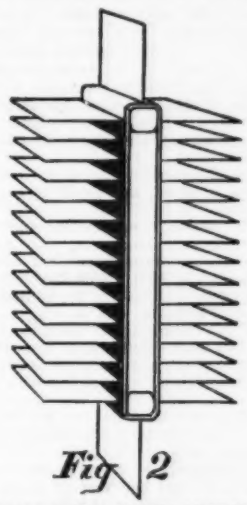


FIG. 2.—ENDLESS BELT, WITH OBJECT CARRIERS.

object carrier and of the pawl and ratchet device of the driving roller. It consists of a rectangular case, A, of any suitable wood, which is made with a double bottom. The lower bottom or base plate, D, is attached to a table or other support, to which the upper bottom, C, or the bottom proper of the case, is hinged, so that the case swings readily thereon. The whole case is adjusted on the lower bottom to any degree of inclination by a crank shaft and pinion, meshing with a fixed arc-shaped rack of the base plate, as shown in Fig. 3. The top of the case, A, is closed by

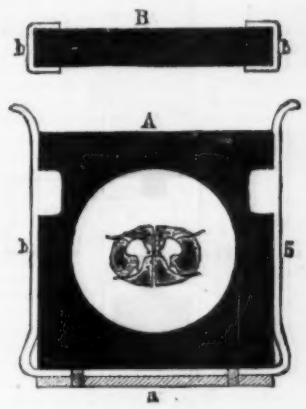


FIG. 6.—PLAN VIEW OF OBJECT CARRIER.

a hinged cover, B, which may be thrown back entirely, so as to furnish convenient access to the interior of the case. When closed the cover is locked by a suitable device.

The case is arranged with two openings, G and H, of

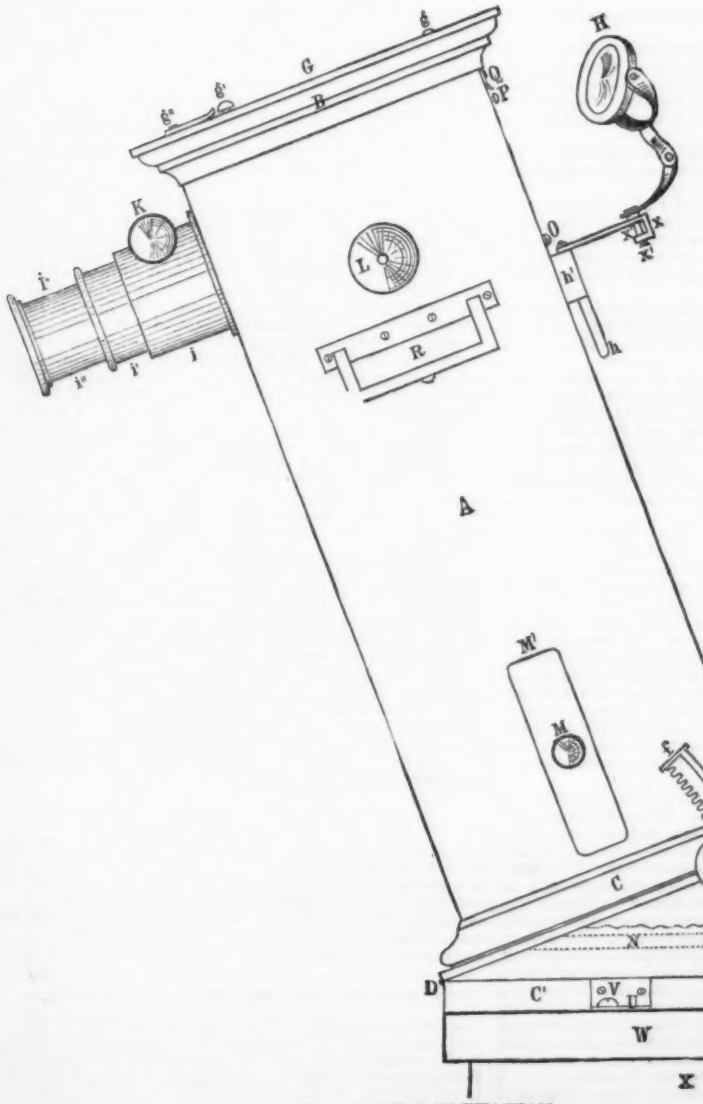


FIG. 3.—SIDE ELEVATION.

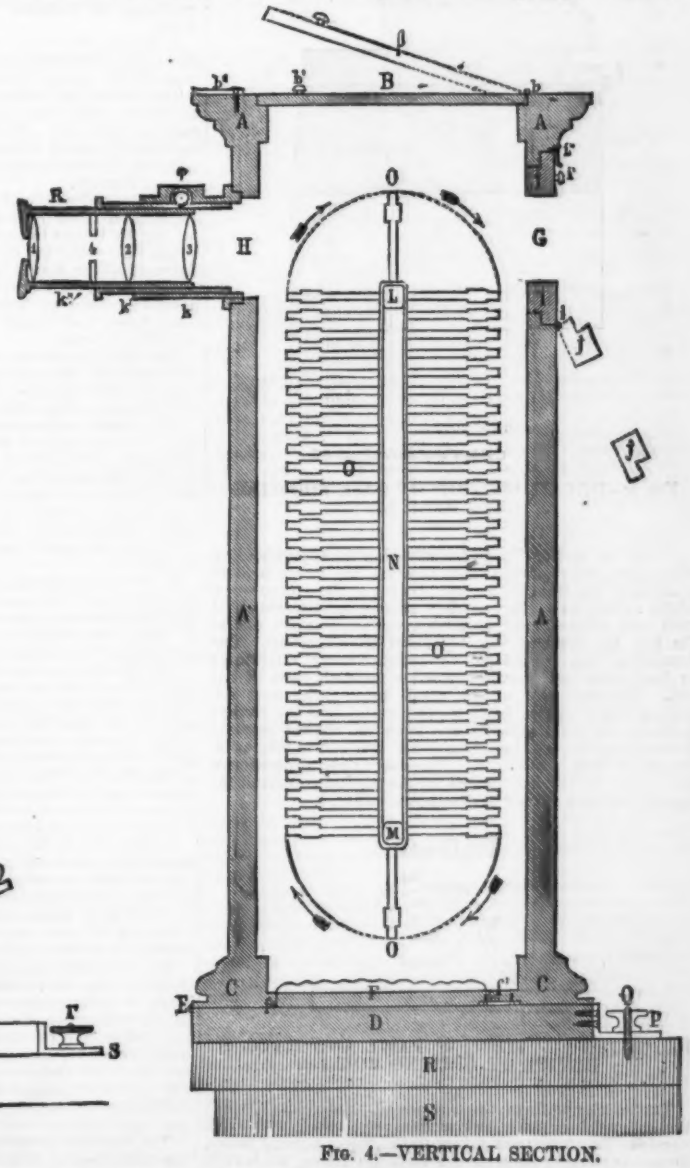


FIG. 4.—VERTICAL SECTION.

IMPROVED POLY-MICROSCOPE.—DESIGNED BY PROF. von LENHOSSEK.

which one is at the front, G, for admitting the illuminating rays, the other at the back for the optical tube. At the front wall of the case is also arranged, by means of three joints, a concave mirror, for the indirect illumination of the object. The mirror is also vertically adjustable by means of a guide rod, socket, and clamp spring, shown in Fig. 3.

The tube is made of several sliding sections with achromatic lenses, so as to furnish a magnifying effect of sufficient power for most microscopic-topographical proportions. At the interior of the case, A, is arranged an endless belt, N, that is stretched over square rollers, M and L, which extend transversely through the case. The belt is revolved by turning the upper driving roller, L, by means of cranks or knobs at one or both outer ends. To the endless belt are attached a number of object carriers at right angles to the belt. A lateral shifting of the belt is prevented by means of guide devices of the upper and lower rollers, which prevent any lateral change in the position of the object carriers. Each object carrier is made of a metallic base frame and two side pieces or arms, which are bent, as shown in Fig. 6, so

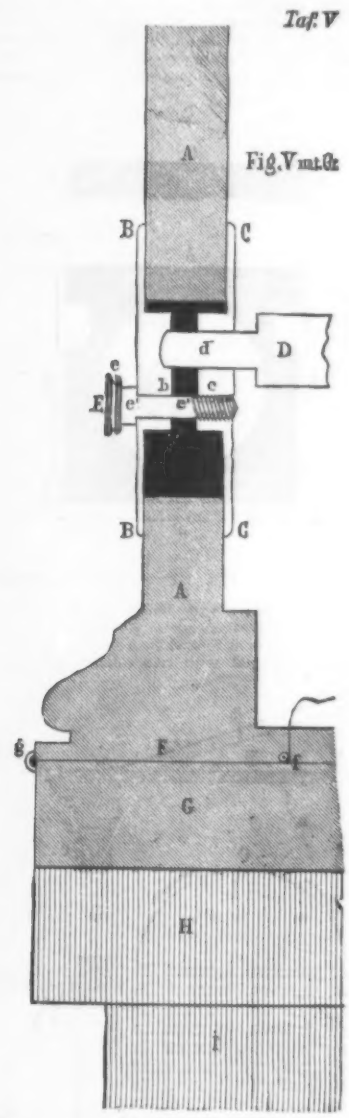


FIG. 5.—DETAIL SECTION OF CASE SHOWING ROLLER BEARING

as to act as spring clamps for retaining the object-holding glass plates, which, when once inserted, are firmly held in position by the frame and arms. Owing to the square shape of the rollers, two object carriers assume simultaneously at each turn of the crank or knob a vertical position, one at the top, the other at the bottom of the apparatus. The remaining object carriers are symmetrically distributed in horizontal and parallel position at both sides of the belt. The next turn of the crank throws the next following object carrier from its horizontal into the vertical position, and the preceding one from its vertical position into a horizontal position at the other side of the belt, as indicated by arrows in Fig. 4. The exact vertical position of each object carrier is indicated by the clicking noise of the spring pawl and ratchet device shown in Fig. 7.

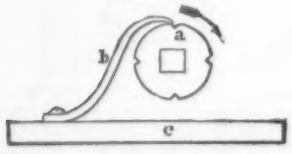


FIG. 7.—DETAIL VIEW OF PAWL AND RATCHET DEVICE OF DRIVING ROLLER.

The interior walls of the case are all painted black, while the endless belt and object carriers are coated with black varnish. To prevent any injury to the object holding plates, in case any one of them should leave its frame, the bottom of the case is bolstered. The cushioned portion of the bottom is hinged and locked, so as to be readily opened for taking out the plate dropped thereon. The endless belt may be stretched from time to time by means of adjusting screws to secure the proper degree of tightness. The apparatus is specially recommended to teachers of anatomy, botany, etc., and also for anatomical museums, and for general microscopic applications, in which a successive series of objects is desired to be exhibited in a connected and progressive manner.

THE PEABODY MUSEUM.

THE Boston *Herald* gives a description of the Peabody Museum of Natural History, at Harvard College, and enumerates the following collections among the possessions of the institution:

Among the important additions by gift are the Mortillet collection of M. Gabriel de Mortillet, of France, which, when he became officially connected with the great national museum of archæology at St. Germain, he was forced to sell, under the French regulations that prevent an officer of a museum from holding a private collection. This collection, embracing about 3,000 specimens, chiefly illustrates certain recognized conditions of the human race in France. The objects were arranged in two classes—those of the "Age of Stone" and those of the "Age of Metals."

The Clement collection, made by Dr. Clement, of St. Aubin, Switzerland, of nearly 2,000 specimens belonging to the age of stone and the age of bronze, chiefly from the "Lake Dwellings" near Concise, St. Aubin, and Lake Neufchâtel. A portion of this collection—the largest of its kind in this country—was exhibited in Paris during the great Exhibition of 1867, and attracted much attention from archæologists.

A series of 50 well-preserved Etruscan vases, comprising 10 different types of form, was given by Signor Augusto Castellani, of Rome.

The Cushing collection, from Mexico—126 pieces—comprising idols in stone and terra cotta, also pitchers, vases, musical instruments, and numerous other articles in terra cotta—were presented by Hon. Caleb Cushing, who, having command of one of the divisions of the United States Army, obtained these relics while he was holding a position near the City of Mexico. Nearly all of these are of the ancient Mexican forms, and were chiefly taken from the excavations along the slopes of valleys and from places of burial. Many of them are still coated with the soil in which they were deposited.

The Rose collection was made by Mr. Wilmot J. Rose, while engaged in constructing public works in Denmark and the Duchies of Schleswig and Holstein. The whole series comprises 1,559 specimens, of which about 50 are of bronze or iron, a few of bone, and the rest of stone, chiefly flint. This collection is one of very great value, since the Danish Government now reserves, by law, for its own museums, the results of all explorations in its country.

Two important additions were early made by the Boston Athenæum and the Massachusetts Historical Society, both of these institutions having deposited here the ethnological specimens owned by them. These collections contained 361 specimens of valuable objects from various parts of the world.

A highly interesting collection of 75 crania, chiefly of ancient Peruvians, and of a Peruvian mummy, was obtained from Mr. E. George Squier.

The Boston Marine Society has deposited a collection of 151 pieces, comprising an excellent series of clubs, spears, paddles, bows and arrows, canoe models, badges of office elaborately carved, different kinds of musical instruments, clothing, and ornaments, which were collected early in the present century.

The Boston Society of Natural History has also deposited a collection made by Henry D. Thoreau, of Concord, comprising 900 Indian implements of stone.

The Fast collection comprises a series of objects, mostly the work of the Aleuts, bought of Capt. Edward G. Fast, who collected them during the years 1866 and 1867 on the northwest coast of America. These include carvings in bone, horn, and wood, of most elaborate and skillfully wrought patterns.

The Chas. Hammond collection, presented by his nephew, Mr. Samuel H. Russell, consists of nearly 400 implements of stone, derived almost exclusively from the towns of Chatham and Rochester, Cape Cod.

The Christy collection of about 125 objects, either originals or casts, is from the celebrated rock shelters or cave dwellings at Les Eyzies, La Madeleine, and Le Moustier, in the Department of Dordogne, France, and from England, Mount Sinai, and the Cape of Good Hope. The Museum of Comparative Zoology, in addition to many small gifts since made, transferred to this museum all its ethnological and archæological specimens, consisting of several hundred varieties.

Dr. C. C. Abbott has presented several collections, comprising several thousand specimens of implements of stone gathered from the immediate neighborhood of Trenton, N. J. This is the largest collection of its kind ever made by one person from a limited section in this country.

The Nicolucci archæological and ethnological collection was presented by Col. Theodore Lyman. In this collection there are 100 crania, some of them antedating the Christian era, and 790 stone implements from the Italian peninsula.

The Agassiz collection consists of a large and valuable series of objects obtained by Prof. Agassiz during the voyage of the Hassler. This vessel, in the service of the United States Coast Survey, sailed from Boston to San Francisco, by way of the Straits of Magellan. In the collection there is a large number of Peruvian crania.

A collection of 378 stone implements from the Western States was purchased of the collector, Mr. G. W. Morse; another of 160 specimens of earthen dishes and vases, and stone and bone implements from the mounds in Missouri, collected by Prof. G. C. Swallow, was purchased of him. This latter collection is quite important, as it is particularly rich in articles of pottery and stone of the Mound Builders.

Mr. Alexander Agassiz collected and presented 168 articles obtained from the Indians of Peru and Bolivia. The pottery ware, of various shapes and sizes, shows that in the ceramic art, as well as in weaving, the present Indians are far behind the prehistoric race of the country. He also presented a collection of 457 specimens from the ancient burial places, and from the surface of the coast of Peru, and another of 120 pieces of ancient pottery from Chimbote, Peru. The collections of Mr. Agassiz form one of the most important and extensive ever received by the Museum.

The Peabody Academy of Science at Salem presented one collection of 730 distinct entries, comprising several thousand specimens collected by numerous scientists in various parts of America.

TWO WAYS OF EXPLAINING NATURE.

[From Prof. Newcomb's St. Louis Address.]

FROM the earliest times at which man began to think, two modes of explaining the operations of Nature have presented themselves to his attention. These modes are sometimes designated as the teleological and the mechanical.

The teleological explanation of Nature presupposes that her operations are akin to human actions, insomuch as they are under the control of and directed by one or more intelligent beings having certain ends in view; that the events are so diverted as to compass these ends; and, finally, that the relation of the events to the ends admits of being discovered by observation and study. This last condition is a very important one, because without it the teleological explanation of the course of Nature would not belong to the domain of science. The doctrine that the Author of Nature has certain ends in view, and directs the whole course of events so as to bring them about, will not enable us to explain and predict the events unless we know what those ends are. But as I have already said, the test of scientific advance is the power of foresight—of foreseeing what result any combination of circumstances will lead to. If we always had to wait for the result, and could then only say, I know this is the result which was intended, because it has happened, no actual foresight would be possible, and however excellent the doctrine might be as a theological one, it would not admit of being tested by observation and experiment, and the question of its truth would not therefore admit of being settled by scientific investigation. You may recall the remark of a satirical philosopher when he saw the gifts which those who escaped the dangers of a certain treacherous and stormy sea offered up to the goddess who had this sea at her command. "I see no offerings from those who were lost," said he. It was not till the voyager had got safely to shore that he found himself under the protection of the goddess. It must be well understood that the teleological theory of nature, or, as it is more familiarly called, the explanation of natural phenomena by design, has two distinct forms—the scientific and the theological. These forms are not antagonistic ones, the one held by scientific men and the other by theologians, for, as you may well know, the scientific form is the one in which scientific men almost universally reject the teleological theory, while they have nothing to say against the other form.

The forms refer only to the fields to which the theory may belong, the scientific and the theological. The distinction turns on whether we suppose the ends which the Creator has in view to be discoverable by scientific investigation, or to be inscrutable. Only in the former case have we, as scientific investigators, anything to do with the question. Now, as we shall more fully see hereafter, the number of ends supposed to be scrutable has constantly diminished with the progress of knowledge, and the theory of design on the scientific side has narrowed its scope in proportion. The only scrutable end which Nature is now supposed to have in view is the good of living creatures, and especially of man, and even in this field we know so little about what is good for us individually that we have only a slight clew to the result. On the other hand, the number of events which directly or indirectly interest us is so great that the slight clew may be supposed to lead to many knowable results.

The other explanation of Nature is the mechanical one. It assumes that her processes go on in accordance with certain laws which admit of being fully comprehended by the human mind, so far as their effects are concerned. Each state of things is the effect of the state which immediately precedes it, and the cause of that which immediately follows it. The course of Nature is thus considered as an endless chain, of which the work of science consists in making out the form of the links and the modes in which they are connected. In this investigation we have to be concerned with two things—the general laws of Nature, as they are familiarly called, and the facts or circumstances which determine the operation of these laws. This distinction is most clearly seen in human laws. Thou shalt not steal is a law; that John has stolen is a fact. The combined result of the law and the fact is that John is locked up in jail. So, that all bodies near the earth gravitate toward it with a force directly as their mass and inversely as the square of their distance from its center, is a universal law of Nature. The Niagara River and the precipice are facts—the cataract is the result.

But the general explanation of the course of Nature on the mechanical theory is not of this simple kind, because the laws of Nature do not act singly, but in combination, so that the result of each is modified by the action of all the others which come into play. The law of gravitation is not that all bodies must fall, but only that they tend to fall, and therefore will fall unless held up by some sufficient opposing force. So long as I support this weight in my hand it does not fall, because the force of gravitation and the resistance of my hand neutralize each other. But the instant I let go, the weight drops according to a certain law known as that of uniformly accelerated velocity.

The doctrine I am endeavoring to elucidate is this: Knowing a few simple laws of Nature, of which gravitation is one; knowing also the arrangement of material things within the field of investigation, that is, knowing the facts, we can predict with unerring certainty what the result will be, or, if we cannot predict it, it is not because of any quality of the thing itself, but only because of the insufficiency of our powers. Moreover, these results will be, as it were, another layer of facts, from which it is possible to predict new results to follow them, and so on without limit, unless some facts from without intervene to change the course. If we include the whole of Nature in our field no outside facts can come in, and her course therefore admits of being predicted with entire certainty from beginning to end.

AN ANCIENT SANSKRIT WORK.

A YEAR ago an ancient Sanskrit work, by Varah Misera, on methods of determining the location of natural springs and underground water courses, of sinking wells, building reservoirs, and like matters, was published in Madras. The curator of the Government book establishment says that the work, which is about 2,000 years old, has apparently been resuscitated under the pressure of the recent famine in Madras.

ACCRETION OF SOIL IN LARGE CITIES.

A STRIKING instance of the constant accretion of soil in large and populous cities has just been developed in London. In excavating for the foundation of a large building in the Poultney—a continuation or part of Cheapside—it was found necessary to dig to the depth of 40 feet from the ground level, owing to the discovery of foundations of old London and of walls of stone rag work supposed to have been constructed by the Romans.

(Continued from SUPPLEMENT No. 142, page 2261.)

ELECTRIC LAMPS IN PARIS.

In this case the moving power is only about a twentieth of the total cost, while three-fourths of the total is put to interest and depreciation. The parties whose results we have quoted estimate that the cost of an equal amount of light from gas to that supplied to their establishment by these machines would be double. But the question of relative cost involves many considerations and must vary with circumstances, and especially with the cost of gas, which in this case is stated at 7 shillings 6 pence ($1.75) per 1,000 feet. In Paris the cost of gas is to the private consumer 30 centimes per meter cube. The cubic meter is in round numbers thirty cubic feet; consequently the cost of Paris gas in American currency is $2.50 (say 10 francs) per 1,000. But the city pays only half that sum in consideration of the monopoly and of their having an equal share in the earnings of the company after a certain sum—say 10 per cent. on the original capital—has been paid to the stockholders.

I am informed by M. Alphonse Barlet, the engineer in charge of the Belgian railways, that he has installed four electrical lanterns—with the old style of regulator—in the gare or station of the Bruxelles Railroad at a total cost of 20,000 francs (say $4,000) for one Gramme machine, one eight horse power steam engine, eight regulators, two to each focus of light (*foyer*), and all the accessory conductors, etc. These four electrical lamps take the place of 120 gas-burners (*becs de gaz*), each consuming 150 liters per hour (four and a half cubic feet). The light now obtained from these four electrical lamps, M. Barlet estimates, equals at least to what would be got from 500 such gas-burners as he used before. But for comparison of cost the statement is made, between the 120 burners actually used before and the electrical costs with the general result, that in the long nights, when the use of illumination is for eight hours during about seven months of the year, the electrical light is cheaper than the gas. But in the summer, with only two or three hours' use of the light, the electrical costs more than the gas light. The reason is obvious. The wages of the engineer and of the electrician are the same in both cases, and the interest on cost the same for the shorter as for the longer duration of the light. But on the whole the electricity was the cheaper and the light abundantly more. On the other hand, the Northern Railway station in Paris, which was illuminated by the electrical lanterns, has returned to the gas, and the publications of the Paris Gas Company, which are before me, make it clear that in their judgment electricity cannot compete with gas. I have paid some critical attention to the Paris gas usines, and shall take another occasion to say something in detail upon the gas industry here. It is at present sufficient to say that no more beautiful exhibit exists in the grounds of the present Exhibition than that of the *Compagnie Parisienne d'Eclairage et de Chauffage par le Gaz*. And nowhere are the principles of science better combined with the practice of the art than they are in the various usines of this immense company.

It remains now to say a few words on the regulation of the electrical light—the candle of Jablochkoff and the new form of the Gramme machine with alternating currents adapted to the use of the candle of Jablochkoff.

I remember well the excitement occasioned by the first appearance of the electrical light in the well-known sunrise scene of "Le Prophète," in the Grand Opéra at Paris in 1846. The regulator then used was devised by M. Deleuil, a well-known instrument-maker of Paris, but his form of the regulator was soon replaced by that of Duboscq, which is an apparatus found to-day in nearly every physical cabinet. In all forms of regulator before the Jablochkoff candle the unequal march of the two carbons had to be provided for by a mechanism which advanced the positive carbon twice as rapidly as the negative, so that the focus of light remained (or was intended to remain) constant. All forms of the regulator were destined primarily for the voltaic arc, and the difficulty of manipulating two carbon pencils was common to all forms of the apparatus. Every experimenter who has tried the regulator knows only too well what these difficulties are. These difficulties have been in a great degree overcome by the ingenious device of the young Russian officer, M. Jablochkoff, who, by simply placing the two carbon pencils side by side, and insulating them by means of a thin plate of some refractory substance placed between them, has dispensed entirely with all forms of regulating apparatus. Those who have not seen this very neat little contrivance will understand it if they consider a common lead-pencil reversed, *i.e.*, its two wooden halves are the carbons and the central lead is the insulator, only this insulator completely separates the two carbons in all their length. This pencil, or candle, as it is well called, is held in a pince or vise of metal, the two jaws of which represent the two electrodes. At the upper end of the pencil is a narrow bridge of carbon, which completes the circuit, and, like the tip on a match, is inflamed by the first impulse of the electric current, thus immediately setting up the ignition. After that the arc itself is the conductor, and the light streams out with its well-known brilliancy. Four of these pencils, or candles, are mounted in each of the glass globes, and so arranged that they are ignited successively as each one is consumed, the time for each being from one and a half to two hours, according to the thickness of the carbons. The light is not absolutely uniform. There are the well-known variations familiar to all who have experimented with the electrical light, and the violet rays, which are so fatiguing to the eyes, are often visible, and, as will be seen by this statement, the duration of the light is limited at present to eight hours. This last limitation can probably be removed by mechanical improvements, which it is needless to dwell on here. But taken as it is with all its defects, and abating at discretion the too favorable statements of those who are interested parties, we must all agree, who have seen it here in Paris, that it is the wonder of the occasion; and that is saying much, for there are some other wonderful things here, of which, perhaps, the great balloon is the freshest novelty. But the use of the Jablochkoff candle involved the necessity of a novel construction in the Gramme machine and in all other magneto-electric machines of a constant current in one direction. The reason is obvious. The positive carbon is consumed twice as fast as the negative, and this would be fatal to the use of the famous "candle." This difficulty could be met only by producing an alternating current, and this has been successfully accomplished by M. Gramme in his new machine. This has been easily accomplished by the use of a small magnetic machine, supplemental to the illuminating engine, which acts as a commutator, which effects at a velocity of 800 revolutions a reversal of polarity—alternation of plus and minus—64,000 times in a minute. By this simple device the Jablochkoff candle burns with entire uniformity.

At this moment there are three models of the Gramme machine with alternating currents. The first supports sixteen Jablochkoff candles of "100 becs"—*i.e.*, of an intensity each equal to 100 gas-burners—consuming five cubic feet of gas and yielding each 200 candle power. It may be safer to rate these burners at 15 candles, which would be the same as saying each Jablochkoff globe equals the light of 15,000 candles. But this is not what is meant by the statement here. It means that one such electrical lamp extinguishes 100 gas-burners; but it is claimed that the actual intensity of light provided is equal to much more than that, as M. Barlet states in his experience in the Bruxelles gare. This first model of the Gramme machine requires an engine of sixteen horse power to drive it, and costs, with its motor, 10,000 francs, say $2,000; it weighs 650 kilogrammes, say 1,500 pounds, and makes 600 turns per minute. The whole weight of copper induction wire in action is 103 kilogrammes, about 125 pounds. The second machine is good for six Jablochkoff candles, requires six horse power to drive it, and costs, with its motor, 5,000 francs, say $1,000. It revolves 700 times per minute and weighs 280 kilogrammes; the weight of copper wire in action is 40 kilogrammes. The third form of apparatus feeds four Jablochkoff candles of 100 becs each, requires four horse power to drive it, and costs with its motor 3,500 francs, say $700. It revolves 800 times a minute and weighs 190 kilogrammes, having 28 kilogrammes of copper wire in action. From this statement it appears that one horse power is estimated for each candle of Jablochkoff, or each 100 gas-burners.

M. Gramme is now occupied on a fourth model which is to feed two electrical lamps, and is much cheaper in both cost and driving power. The Holmes machine and the Gramme are alike in the relative position of the bobbins and the electro-magnets, both being alternating currents. By the simple substitution of a plate of plaster of Paris for the kaolin, at first used for the separation of the two carbons, M. Jablochkoff has, it is claimed, doubled the intensity of the illumination without any increase in the electro-motive force, and the cost of the apparatus has been reduced from 75 centimes to 50 centimes per hour for each electrical candle —100 becs—motive power and depreciation of apparatus not included.

I cannot conclude this letter without reverting to the splendor of the electrical illumination of the new Avenue de l'Opéra, as seen from the balcony of the Grand Opéra. The effect is magnificent, and at this moment there exists nothing in this city of splendid effects to be compared to this magical scene. The surroundings of the Opéra itself —the most majestic theater in the world, no doubt—add much to the effect. There are in view about thirty of these electrical lanterns—a part of those near the Opera House being of the same form (a cone) used by the Paris Gas Company, and the others being opaline globes, already described. The vista is about a third of a mile, and the effect incomparably fairer than any show of artificial illumination ever before seen. It is the light for all public places where a high degree of illumination is desired, as in large shops, cafés, public gardens, theaters, avenues, etc. But it will not displace gas for domestic use nor for common street lights. Great difficulties in the subdivision of the current are yet to be overcome. For the Avenue de l'Opéra, I understand, there are three steam engines, and that at present 200 meters is as far as the current is conveyed. But let us not too confidently predict the future of what is possible in this direction. Of one thing we may be certain—the Parisian Gas Company are wide awake to the public interest in this thing, and will not be slow to add it to their present vast system of works whenever it appears that both their own and the public interest make it desirable they should do so. But in Paris the use of gas in houses is a matter of much less moment than in America, for the old prejudice excludes gas both in London and Paris to a great extent from domestic use. When, then, we learn that the share of profits paid over to the city from their one-half interest in the earnings above 10 per cent. first paid to the Shareholders' Association last year amounted to the round sum of 8,000,000 francs, we can readily understand that the city will act with the company in aggregating any valuable improvement in public illumination to their existing franchises, and that they can well afford to do so even at a pretty round price. The present capital of the gas company is, in shares, 84,000,000 francs, and in debentures 111,745,000 francs, or in the total nearly 200,000,000 francs, or $40,000,000. The modest little capital of 7,500,000 francs which the electrical company represents would be only as dust in the balance to such a huge monopoly. It is interesting to note that the amount paid last year by the city of Paris for gas was 7,827,205 francs—a little less than the dividends raised from the company. But it must be remembered that the tax paid into the city treasury by the gas company last year was 8,500,000 francs, and that the several water companies paid a little more than that—viz., 8,924,577 francs. By this shrewd arrangement the city of Paris annually gains net over all costs for gas more than 8,500,000 francs. When will the several gas companies in New York combine to pay the city as much for their monopoly? Probably not in the fragment remaining of this century.

B. SILLIMAN.

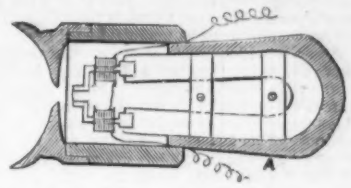
IMPROVED TELEPHONE.

WITH the aid of a rough sketch I will endeavor to explain, says a correspondent of the *English Mechanic*, a pair made by a friend of mine, which, for clearness, have far excelled any of the bar-magnet telephones I have yet heard.

It will be seen that the mouthpiece is not screwed on, but is made with a socket, which fits very tightly, and which also holds the diaphragm plate. The tail piece, A, is a flat piece of wood about an inch in thickness, cut out to admit the magnet, and let into the end of the case. The magnet is held in its place by two brass plates and screws, shown in sketch. The soft iron poles are made square at one end, with a mouth cut in and driven tightly on the magnet; the bent piece for the other end is flat, and fastened on with a screw, which is countersunk. About ½ oz. of No. 36 silk covered wire is wound on each bobbin, one in the opposite direction to the other.

After being put together and regulated, a wood lid was glued on the tail piece; the mouthpiece and diaphragm were taken off, and the telephones nearly filled with paraffine.

As I have said before, the results got from these telephones are much clearer than we have got from bar-magnets. In



IMPROVED TELEPHONE.

speaking through twenty miles of an ordinary telegraph line the other day, the voice of a speaker at the other end could be distinctly heard, when the bar-magnet telephone only gave a confused noise.

THE STEREOSCOPE AND ITS USES.

Circumstances which Enable Us to See the Roundness of Objects.—During the discussion of the aids employed to produce a stereoscopic effect in pictures, the question may perhaps have arisen in the minds of some readers whether it is indeed really necessary to wait until such a peculiar illumination presents itself, or to produce it in the studio, and whether it would not be sufficient to simply reproduce things in precisely those colors which they happen to show at the moment. As nature always makes the impression of bodiliness, it would appear that by a simple, truthful reproduction a strong relief must always be obtainable.

This conception, which we meet with in some of the latest naturalistic school (Courbet, Victor Müller, and others), is based upon a very erroneous conclusion, to which attention was already drawn by Leonardo.

It would be correct if the impression of bodiliness in nature were really produced only by color and by light and shade, that is to say, by the same means which are at the command of the artist. This is not the case, however, for in nature a number of other circumstances are at work which aid us in determining the distances of objects, or of their various parts; or, in other words, which assist us in perceiving the corporeal qualities of the things which we see.

If, for instance, we desire to ascertain the relative position of several objects situated at various distances, we can do so by moving the head or the whole body, as these movements produce unequal apparent changes in the position of the objects, by which changes the judgment is aided. But we possess another exceedingly effective means for perceiving depth in space, even when the body is perfectly at rest, in the mutual activity of our two eyes, a means which is not available to the painter, since he is confined to a plane surface for the representation of his picture.

Fig. 1.

It is a well-known fact that we look at all objects with our two eyes from two different points of view, and that we therefore really see two different pictures of the same object; or, in other words, that the two perspective views of the outer world which are projected upon the retinæ of the two eyes differ somewhat, so that each of these views has a different center of vision.

This is very clearly explained by Fig. 1, which is a copy of a drawing made by Leonardo da Vinci, for the purpose of illustrating the point under consideration. Two balls, M and N, are so placed upon a table that only the nearer ball, M, is visible to the *left* eye, A, of the observer, the more distant ball, N, being hidden by M. The *right* eye, B, however, sees not only the ball M, but also one-half of the more distant ball N.

If we really make this arrangement, and then look at it with unprejudiced eyes, we shall simply see the *two* balls *behind each other*, only that part appearing to be hidden which is also invisible to the right eye. As soon, however, as we close the left and the right eye alternately, we shall find that the view is somewhat different for each.

An analogous case can never be produced by a drawing upon a plane surface; and Leonardo therefore observes, very correctly, that a painted object can never present the full corporeal appearance of a real object, even with the most rigid adherence to all the rules of perspective and of the treatment of color.

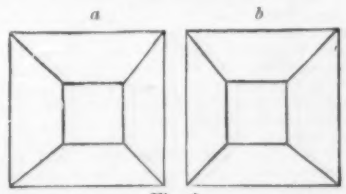


Fig. 2.

The Stereoscope.—This statement by Leonardo, which, although quite brief in the original, is nevertheless very easily understood with the aid of the drawing accompanying it, remained unnoticed until the year 1838, when Wheatstone, following out the same train of ideas, discovered the stereoscope. Wheatstone reasoned very correctly as follows: If two perspective drawings of one and the same corporeal object are offered to the eyes, the two drawings corresponding to the views which the two eyes would in reality receive if looking at the object, and if care is taken that one eye sees only one drawing while the other sees only the other, the impression produced must be the same which would be produced by the body itself, that is to say, the object must appear to be round.

His conjecture proved to be true, and the stereoscope is now to be found all over the world.

The apparatus which is employed in looking at stereoscopic pictures is not indeed absolutely necessary, and after some practice it is possible to obtain the stereoscopic effect without any apparatus whatever. For this purpose it is, however, necessary to give an unnatural position to the eyes, and the stereoscopes are therefore provided with prismatic lenses, which permit the eyes to retain their natural position, and at the same time serve as magnifying glasses.

The difference which must exist between the two stereoscopic views belonging together will perhaps be best understood by the following illustration: Let us suppose a truncated, four-sided pyramid to be placed before us upon a table. Looking at this pyramid from above we shall see somewhat more of its left side with the left eye than with the right, and *vice versa*. The left eye will therefore see the view *a* of Fig. 2, page 2269, while the right sees *b*. If we now look at *a* with the left eye and *b* with the right in the same moment of time, we must also see the pyramid. To obtain this effect we must introduce a partition (best of all a piece of dark-colored cardboard) between the two eyes, so that *b* shall be hidden perfectly from the left and *a* from the right eye, and we must then adjust our eyes as if we wished to look at some distant object, while holding the paper in a vertical position, which is the best for the success of the experiment. Having done this, we shall instantly see the two pictures coincide, and the truncated pyramid will appear before our eyes with its basis turned away from us, and having the appearance of a model made of fine wire.

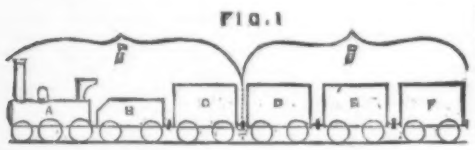
Those who cannot make the experiment succeed with unaided eyes will of course have to use a stereoscope; but the figure will nevertheless serve to illustrate the difference which the two pictures must show.—*Dr. Von Bezold's Theory of Color.*

A FRENCH REPORT ON CONTINUOUS BRAKES.

M. G. MARIÉ, the son of M. Marié, engineer of the Paris, Lyons, and Mediterranean Railway, has prepared a report on continuous brakes for the company. We believe that the following condensed translation of this report, from the *Engineer*, will be found useful and interesting by our readers. M. Marié gives a list of the various authorities which he has consulted and of the sources from which he has obtained his information, which it is not necessary to reproduce.

Different Kinds of Brakes.—For several years public opinion has occupied itself in all countries with railway accidents and the means of avoiding them. Attention has been principally devoted to a search for brakes more powerful and, above all, more rapid in their action than those now in common use. I propose to investigate this question, and to indicate the various systems which have been adopted or tried. The different brakes used may be divided into three classes: (1) Hand-screw brakes. These brakes, fitted to the engines, tenders, carriages, and vans, are worked on each vehicle by a brakesman. The apparatus has the advantage of being simple, but it has two serious defects. We cannot use such brakes without having a man in each carriage to apply it. The men employed in this service having little to do are likely to fall asleep, and they fail in their duty when the engine driver calls upon them. (2) Steam brakes on the engine. In this system it is important that the brakes should act on the driving wheels, because they carry the largest part of the weight of the engine. Steam brakes may be subdivided into two classes: (*a*) brakes actuated by a special steam cylinder, and (*b*) counter pressure brakes. The last has many advantages, among which may be named the following: The working of the brake presents nothing abnormal; it is performed instantaneously. It is possible to modify at will the action of the brake, which extends even to skidding the wheels. No special machinery is needed, the

FIG. 1



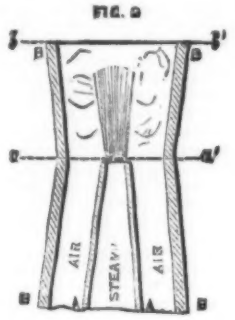
mechanism employed being that of the engine, and being always in use it is sure to be in good order. Again, the brake, notwithstanding its power, produces no sensible shock either in the engine or in the train. Steam brakes acting on the driving wheels are very powerful, because such wheels carry, as regards passenger trains, a very large proportion of the whole weight of the train. (3) We have continuous brakes. Brakes are called "continuous" when they permit the engine-driver to apply them by himself to all the wheels of a train. It will be understood that these brakes, enabling one to skid all the wheels of a train instantaneously, are much more powerful in their action than steam brakes applied to the engine wheels only and aided by screw brakes applied by hand. The force of the brake is much more considerable, and the distance traversed after the brakes are applied is much less.

In France two systems of continuous brakes have been used for some years. These are the Achard brake and the Guerin brake. In the first a current of electricity circulates throughout the length of a train and produces at will under each vehicle an action which puts the axles of the wheels in connection with the brake in such a way that part of the *vis viva* of the wheels and the carriage is used to apply the brake. This system is instantaneous in its action, it is powerful, and it is continuous, but it presents difficulties of construction and working which preclude its adoption in practice. It is impossible to graduate its force, and if it is to be efficient it pulls up a train too quickly, and exposes the passengers to the risk of violent shocks, for which reason it cannot be used in regular service.

In the system of M. Guerin the brake shoes are applied by the contact of the buffers. This brake is not instantaneous, because the brakes are only applied one after the other as the train pushes on the engine. It is not very energetic, because the pressure on the buffers, and, as a consequence, the force on the brakes, diminishes sensibly from the head to the rear of the train, and it presents certain difficulties in backing or marshaling trains. For some years past certain brakes have been used in America, England, and Germany, continuous brakes worked by the pressure of air or by a vacuum, a simple, common air tube transmitting the pressure or the vacuum from the engine throughout the train. Before describing this apparatus it will be well to speak of the different qualities of continuous brakes and of the inconveniences which they present.

Diverse Qualities of Continuous Brakes.—The continuous brakes, which we have now to consider, act upon the entire mass of a train; they are consequently much more powerful than ordinary brakes, and the distance required to produce a diminution in speed or the stoppage of a train is reduced in the same proportion. It is right to insist particularly upon the necessity of constructing continuous brakes in such a way that they will skid the wheels throughout a train if the driver thinks proper. Many inventors have abstained from this, under the pretext that the adhesion of the wheels before they are skidded is a little greater than their frictional resistance when skidded at high speeds. This is possible; but in a case of danger the engine driver could not be sure that he used his brakes quite up to the skidding point without skidding the wheels. In all cases the inventors have profited by reducing the power of their brakes, because the apparatus employed may be made to look smaller and lighter in all trains that are not used for experimental purposes, but they end by sacrificing nearly all the efficiency of their brakes. The best method of establishing the energy of a continuous brake consists in showing that it can skid all the wheels of a train on which it acts.

FIG. 2

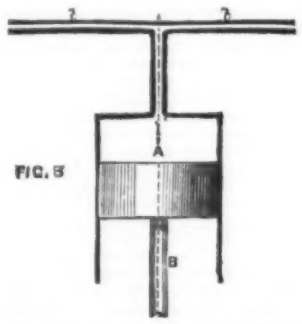


The time which elapses between the action of the engine driver and the application of the brakes varies with different systems. When the brakes are off, the shoes should be quite clear of the wheels, first, to compensate for the wear of the shoes, secondly, to avoid the rubbing of the shoe upon the tire, caused by the play of the axle box in the hornplates, and of the various parts of the brake. It is possible to take up the wear of the brake shoes, but it is impossible to take up slack in the various parts of the brake apparatus. In nearly all the brakes that I have examined the distance is too small, and causes the continual rubbing of the shoes on the tires. It is unwise to reduce the clearance below $\frac{1}{4}$ in. After power, the next necessity in a brake is that the engine driver should be able to regulate the force with which it is applied. He should be complete master of the apparatus, to avoid giving passengers rude shocks, and he should be able to regulate with ease the pressure with which the brake is applied when descending long inclines. These advantages exist, as we shall see, in but a small number of brakes.

Recently it has been demanded that continuous brakes should be automatic or self acting, that is to say, in case of breakage of the tie bar or coupling the two portions of the train should both be acted on by the brake without the intervention of any one. Otherwise, if a train broke in two on an ascent, the hinder part would at once run away down hill unless the brake prevented it. It is true that it might be stopped by the ordinary hand brakes, but the guards, unaccustomed to their use, would be less ready than now to apply them. This is the best reason that has been adduced for making continuous brakes self acting; but it will be understood that it is not possible to obtain this advantage save at the cost of very great complexity, which may cause trouble and sometimes accidents. Continuous self-acting brakes may be so arranged that they can be applied not only by the engine driver, but by all the guards in a train, and even by the passengers. It is also easy to understand that the brake can be put on by the intervention of a current of electricity started when the engine passes a signal set at stop.

Such improvements are of a kind more likely to please an amateur than to meet the conditions of actual service. The coupling of the carriages should be as simple as possible. Air brakes, for example, render the breaking and making up of trains very difficult, and cause much inconvenience.* It is advisable that the couplings should be so made that the carriages can be used end for end. Lastly, it is advisable that the men who marshal the train should be able to take the brakes off without the aid of the engine. Let a train be composed of a certain number of vehicles, A, B, C, D, E, F; let P be the total weight of the train. I assume that the engine ceases to pull, and I neglect the resistance of the train. Let the train be divided into two parts, the first, A, B, C, having a weight which is represented by x, and the part in the rear, D, E, F, having a weight $P - x$; let T be

FIG. 3



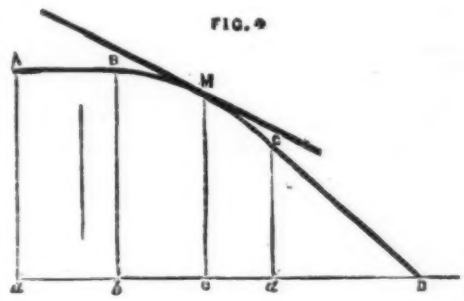
the tension on the couplings. T will be a maximum if $x = \frac{P}{2}$; and if all the wheels of D, E, F are braked, the others remaining free, this maximum tension will equal $\frac{P}{4} \times f$, f being the coefficient of friction of the wheels on the rails, or $\frac{1}{7}$ at the most. This is a case the most unfavorable that it is possible to present. A train of 200 tons would thus put a tension of 10 tons on T. This is a great deal, but the case would scarcely ever occur. It supposes the action of the brake is perfect in the rear of the train, and not in the front. This is the opposite of what generally takes place. If the engine continued to pull, this pulling would cause an increase in the strain on the couplings. It must not be overlooked that this great tension might cause the breaking of a coupling when an incline was being ascended. The giving way of the coupling might not be perceived, and an accident would occur unless the brake was self acting, or without the intervention of the hand brakes.

Engine drivers should not rely on continuous brakes when entering terminal stations, because if they fail an accident will follow. This happened on the Jersey Central Railway, when a train fitted with a vacuum brake ran at speed into a terminus, struck the offices, and fell into a river. Lastly, such brakes are often expensive in the first instance, and costly to maintain. All the continuous brakes that we have augment the weight of the carriages; we may count in general on about 9 cwt. 3 qr. as the smallest weight of the apparatus for a six-wheeled vehicle. This, of course, augments the cost of traction. I shall now proceed to describe the various systems of continuous brakes in use.*

Chain Brakes.—The advantages of the chain brakes of Heberlein and of Webb and Clarke are that these brakes are very energetic, and very easily applied to all the wheels of a train; an ordinary wagon can be made up in a train fitted with a chain brake by simply passing the chain beneath it. These brakes can be rendered self acting. The coupling of the carriages is hardly interfered with. The disadvantages of such brakes are that it is impossible to regulate their action or prevent them from producing jerks. They are emergency brakes, which should not be used in regular work, but only when danger is incurred. Notwithstanding the rules which are laid down for their use, an apparatus which is seldom used may fail us just when we want it. It is difficult to make the communication cord on the top of the carriages act, while the violent jerkings caused by the action of the brake may sever the couplings. The chains are liable to be broken.

The Westinghouse Air Brake.—As regards the Westinghouse compressed air simple brake, its advantages are that it is a system with few encumbrances and very simple. We dispense with the leather and caoutchouc which are used in the vacuum brake, and the engine driver can apply the brakes with just that force which he thinks desirable. Its defects are that it is not self acting, the coupling of the pipes is not easily effected, and if the coupling leaks the reservoir is soon emptied and the action of the brake is destroyed. This might occur when running down long inclines. The air pump fixed on the engine is an apparatus a little delicate, and its working represents an outlay for coal. The system has been used for some years in the United States. Mr. Westinghouse, pressed by public opinion, has substituted a self-acting brake which is much more complicated, but which, nevertheless, is taking the place of the simple brake.

FIG. 4



The Vacuum Brake.—Mr. Smith, in his vacuum brake, employs a very ingenious apparatus, named an ejector, to produce the necessary exhaustion. It is composed simply of two concentric tubes, A and B, Fig. 2. The steam escaping from the boiler through the tube A, by its friction on the air, augments its pressure between *a a* and *b b*. To increase the augmentation of pressure of the air in its course from *a a* to *b b*, the outer pipe is made of considerable length and widened upward, as shown. The pressure of the air in *b b*, on its arrival in the atmosphere, is equal to the pressure of the air, and it is possible, by arranging the apparatus properly, to obtain a vacuum under the carriages which will not exceed one-third of the pressure of the air. This apparatus is small, and requires little attention. It is easy to render it very powerful by sending through it as much steam as the engine makes when running, and the expenditure of steam is very small, because the brake only works for a very short time. The mechanical theory of heat applied to this species of problem by M. Zeuner shows that such an apparatus as the ejector, when applied to the exhaustion of gases, and not of liquids, is as economical of steam as a pump, and that it may give 200 horse power of useful work. We have, then, by this contrivance, a pneumatic machine of 200 horse power, instead of the 2-horse steam pump of Westinghouse.

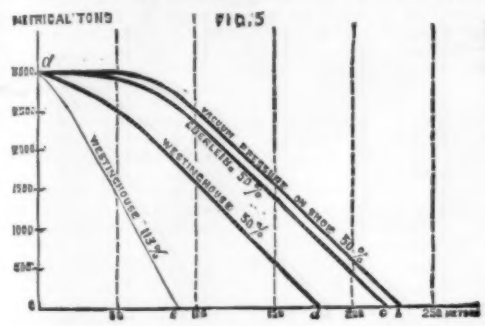
The Hardy Brake.—M. Gottschalk, Engineer-in-Chief of Austria, has replaced Mr. Smith's bellows by a cylinder, which is more practical, and has been adopted by the Vacuum Brake Company. The arrangement has been designed by Mr. Hardy. The advantages of the brake are that its intensity of action can be graduated by the engine driver; leaks throughout the system cause no other inconvenience than an increased expenditure of steam; the coupling of the pipes is very easily effected; if one of the brakes should be damaged, the others can still act; all the parts of the brake are very simple, and of considerable dimensions. Its defects are that it is not self acting; it requires a little more time to apply the shoes to the wheels than the Westinghouse and chain brakes, and, in order to act well, the bellows must be of large dimensions; it is less energetic than the Westinghouse and chain brakes; the ejector makes a great deal of noise, to the alarm of the passengers when the train enters a station, and this noise cannot be got rid of; the bellows, or vacuum sacks, are of India-rubber, a material badly adapted for such a purpose. The cylinder of M. Gottschalk is an improvement in this respect.

* M. Marié has fallen into a slight error here. The couplings used in the Westinghouse brake, for example, are so simple that they present no more difficulty in putting together or in opening them than does the hooking of two chains together.

* We have not thought it necessary to reproduce this portion of M. Marié's paper so far as it deals with systems of brakes well known in this and other countries.

The Sanders Brake.—The Sanders vacuum brake has the advantages and defects of the Westinghouse and vacuum brakes. Its advantages are that it is self acting; the coupling of the pipes is simple and excellent; the engine driver can graduate the action of the brake at will; it gives no shocks to passengers. Its defects are that it becomes very cumbersome if we wish to make it more powerful than the inventor has hitherto made it; it requires a small pump more than the vacuum brake.

The Wenger Brake.—Mr. Sanders took, in 1874, a patent, in which he mentions the principle of a self-acting brake, which differs from the preceding. In this system the shoes are applied to the wheels by a weight or a spring working in a vacuum cylinder placed on each carriage. In ordinary work the engine driver keeps the brakes off by maintaining a vacuum in all the cylinders as in the ordinary Sanders brake. This system does not seem to have been applied in practice. M. Wenger, an engineer of the Lyons Railway, hit on the same idea during a recent trip to England. He has worked out the scheme to completion, and adopts the arrangement illustrated by the accompanying engraving, Fig. 3. Each vehicle is fitted with a cylinder, A, in which is inclosed a weight carried on a rod, B, which applies



the brakes to the wheels. The weight forms a piston. By maintaining a vacuum above it, the brake is kept off. By admitting air through the pipes, *t t*, the brakes are instantaneously applied. When a carriage is removed from the train the brake is applied automatically until the weight, which amounts to nearly 4 cwt., is lifted. This is very inconvenient, but a key may be used to keep the weight up. The advantage of the brake is that it is self acting; that it can be graduated in its application; that it can be made very rapid in its action; in case of danger it is certain to act with its full power. This advantage is not possessed by any other self-acting brake. For example, if the engine driver did not maintain a sufficient pressure in the Westinghouse reservoirs, the brake would not act with full efficiency. Its disadvantages are that it is heavier than other brakes; that if we forget to take out the keys before referred to, the brakes are inoperative; and that if, when parting a train, we forget to put them in, much delay and inconvenience may be caused. M. Quesnot, inspector attached to the traffic department of the Lyons Railway, has designed an arrangement by which the keys are put in and withdrawn by the engine driver by means of small pistons and air pipes.

Comparison of Continuous Brakes—Experiments Made in Germany.—The best quality of a continuous brake is its energy; thus numbers of experiments have been made to compare them from this point of view. The German railway companies have made very important comparative experiments, which I shall describe with some detail. In the first place, the apparatus used was constructed by the companies, and not by the inventors. The different brakes were all used in such a way as to produce finally the same force upon the brake shoes, so that the comparison did not extend beyond the time lost between the moment when the engine driver put on the brake and that when the brakes reached their maximum effect. The value of the act of braking (*serrage*) is expressed by the relation between the pressure of the shoes on the tire and of the pressure of the wheel on the rail. The brake force is 90 per cent. if the pressure on the shoes is 90 per cent. of the weight which rests on the rail, including the weight of the wheel. The shoes were all made of the same material in all the systems of brake tried—that is to say, the chain brake of Heberlein, the Westinghouse, and the vacuum brakes. On the permanent way were placed electrical contacts which, on the passage of a train, caused a tracing point to mark a paper drum revolving uniformly. Thus the position of the train could be ascertained at any moment, and this defined the law of retardation.

To place before the eye the results of these experiments, I have employed a mode of representation designed by the German engineers. Take for abscissæ the spaces traversed by the train in meters, and for ordinates half the *vis viva* of a train at each electrical contact in metrical tons. Let P be the weight of the train, without considering the wheels, and p the weight of the wheels. Let v be the speed of the

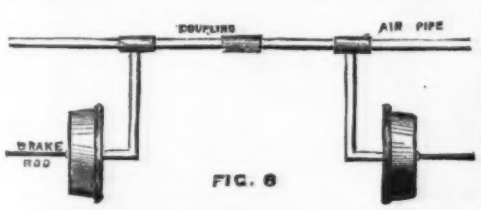


FIG. 6

train. The half *vis viva* of the train is composed of the half *vis viva* of translation, or $\frac{P+p}{2g} v^2$ plus the half *vis viva* of the revolving wheels, or $\frac{P}{2g} v^2$ supposing all their mass to be situated at their circumference. The half *vis viva* "total" of the train is $\left(\frac{P+2p}{2g}\right) v^2$. It is the half *vis viva* which is represented by the ordinates. The object of the brakes is to destroy, or, more properly, to convert into heat the whole or the greater part of this half *vis viva*.

I shall now show that the angular coefficient of the tangent at any point in the curve of half *vis viva* is proportional to the augmentation in pressure on the shoes—that is to say, to the action of the shoes on the wheels. In effect the angular coefficient has for its value $\frac{d(M v^2)}{d e}$ or it equals

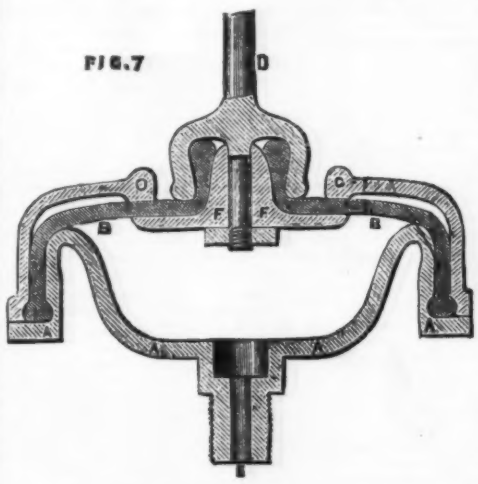
$$\frac{v\,dv}{de} = \frac{de}{dt} \times \frac{dv}{de} = \frac{dv}{dt} = \gamma$$

(e represents the spaces, t the times, v the speeds). Thus when the curve is parallel to its abscissæ, the motion is uniform as from A to B, Fig. 4. From B to C the pressure on the brake shoes augments, and when it has attained its maximum at C it remains constant till the train stops at D. The distance run from the point A, where the brake was applied, to the point C, where the desired brake force was obtained, is precisely what the German engineers sought to ascertain, for the purpose of comparing different brakes. I have before said that they had so arranged matters that the final pressure on all the brake shoes should be the same—that is to say, that for all the trains the right lines C D should be parallel. It is the form of the curve A B C which gives the characteristics of the brake.

I have presented in Fig. 5 the results of some of the experiments. The runs were made in fine weather. The brakes were applied only to part of the train, the weight of that portion of the train fitted with brakes being 92 tons, and of the unbraked portion 36 tons, and this was the same for all the brakes tried. It is difficult to explain why the German engineers did not apply brakes to all the wheels. The lines *a b*, *a e*, *a d*, serve to compare the rapidity of action of the vacuum, Heberlein, and Westinghouse brakes. They represent in this case a brake force of but 50 per cent. on the shoes. The line *a e* represents an experiment made with the Westinghouse brake when the force amounted to 113 per cent. of the weight of the braked vehicles. The speed of the trains was in all cases 75 kilometers—46 miles 1,062 yards—per hour. The distance run with the vacuum brake, after application, was 251·5 yards; with the Heberlein brake, 240·6 yards; with the Westinghouse brake, 196·8 yards.

Conclusions.—I conclude by giving my opinion as to which is the best system. If we determine not to have a self-acting brake, the vacuum brake appears to be the best, substituting for the India-rubber sack or bellows, the cylinder and diaphragm of Mr. Hardy, or a metallic cylinder and piston, because I hold that the India-rubber sack offers many objections. If we conclude to have a self-acting brake, then that of M. Wenger seems to be the best. It is difficult to understand the preference for self-acting brakes. It would be necessary to make a kind of statistical investigation of accidents before arriving at fixed conclusions on this point.

Summary of Patents Concerning Continuous Brakes.—It is generally believed that the continuous brake is an American invention. This is not correct. In this case, as in many others, the invention first saw the day in France, to be applied in another country. The first idea of a continuous brake to be worked by a vacuum or by compressed air is due to two Frenchmen, MM. Verdat du Tremblay and Mar-

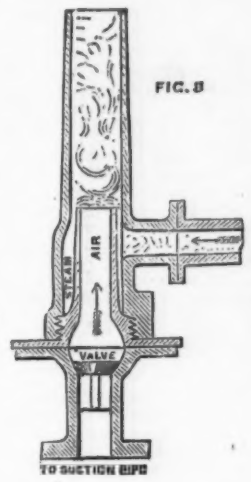


tin, civil engineers, of Rouen. They secured in 1860 a patent, of which I shall give a *résumé* in a few lines. It will be seen that these engineers have described the principle of all vacuum or compressed air brakes. As this patent is public property—at least in France—nothing more can be patented than matters of detail.

The Tremblay Brake.—The pneumatic brake of MM. Tremblay and Martin is composed of (1) an air pump put under the engine, and worked by an eccentric on an axle; (2) of a metallic cup under each vehicle. This cup is closed by a diaphragm of India-rubber or any other elastic material, supported by a metal disk. When a vacuum is made in this cup the membrane is drawn in and pulls on a rod which applies the brakes. It is easy to calculate the dimension of the cup when the requisite data are supplied. Figs. 6 and 7 show the vacuum brake of M. Tremblay. A is the metal cup, B the diaphragm, C a cast-iron box to protect the diaphragm, D brake rod, E suction pipe, F disk to support the diaphragm. (3) Of a pipe putting all the cups in communication with the air pump. (4) Of two cocks ready to the hand of the engine driver, the one for admitting air to the pump, the other for opening and closing the communication between the cup and the pump. The action will be readily understood. Its energy can be controlled at will by the engine driver. To make the brake work with compressed air, a cylinder and piston take the place of each cup. On the 27th of December, 1860, M. Tremblay filed an addition to his specification, which runs thus: "Among the means of making a vacuum which may with advantage replace the air pump, we see that which we have made the object of the present certificate of addition. It is based upon the induction (*l'entrainement*) produced by the speed of a current of steam of high pressure upon the molecules of air with which it is put in contact. The apparatus is very simple, and is shown in the accompanying drawing, Fig. 8. We can obtain a vacuum of 45 centimeters—17·7 ins.—of mercury with this apparatus."

We have here the essential portions of the patent in question. We see that this is a complete description of the vacuum brake with its ejector, and with the cylinder of Mr. Hardy, within a little. I may add that the coupling of the pipes, described by the inventor, much resembles that used by Smith. It will be seen that this patent also describes the old Westinghouse brake. Thus the vacuum brake is *tout à fait* public property in France. The only thing that Mr. Smith can patent is the India-rubber sack. As for the cylinder of Mr. Hardy, it is almost identical with the cups of M. Tremblay. The only difference is the substitution of leather for India-rubber, but M. Tremblay says in his patent that caoutchouc may be "replaced by any other elastic material."

The patents of which I shall now speak are *en règle* as regards the payment of fees, but they are for the most part rendered worthless by the forgotten Tremblay patent.



Heberlein.—Patent dated 15th June, 1872. Not annulled by Tremblay.

Westinghouse.—Patents dated 13th March, 1872, 18th June, 1873, and 23d December, 1873. These patents are good, except that the Tremblay patent invalidates the old non-automatic patent.

Smith.—Patented 19th September, 1874, 23d November, 1874, and 8th September, 1875. Invalidated by the Tremblay patent, except as far as regards the India-rubber sack.

Hardy.—Patented August, 1877. We have seen that this system is the reproduction, almost literally, of the Tremblay patent. It appears, therefore, to be annulled. It has not yet been attacked, and it is *en règle* in France.

Sanders.—Patented August, 1877. Not invalidated by Tremblay.

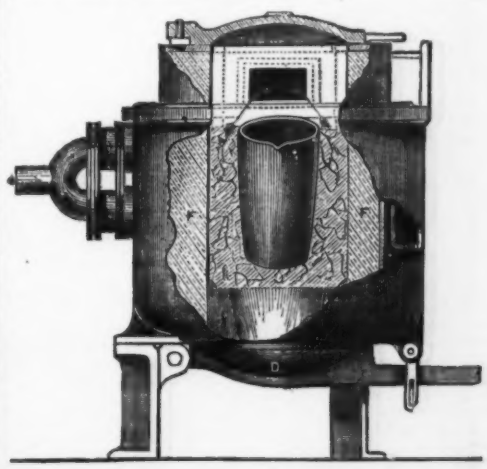
Wenger.—Having applied for a patent, M. Wenger found that the principle was public property. He withdrew his first claim, and has only patented details, under the advice of the engineer-in-chief of the railway, in order to protect the interests of his company should they decide to adopt the brake.

Royalties to be Paid by the Paris and Lyons Railway Company.—I have concluded in favor of one of the three following systems: (1) Wenger's brake. M. Wenger is to be paid no royalties by the company. (2) Vacuum brake with a cylinder and piston, instead of an India-rubber sack. This disposition was devised by M. Tremblay, and no royalties need be paid. (3) Vacuum brake with cylinder and diaphragm of Mr. Hardy. This patent being invalidated by Tremblay, can be applied without paying royalties, under the name of the Tremblay brake.

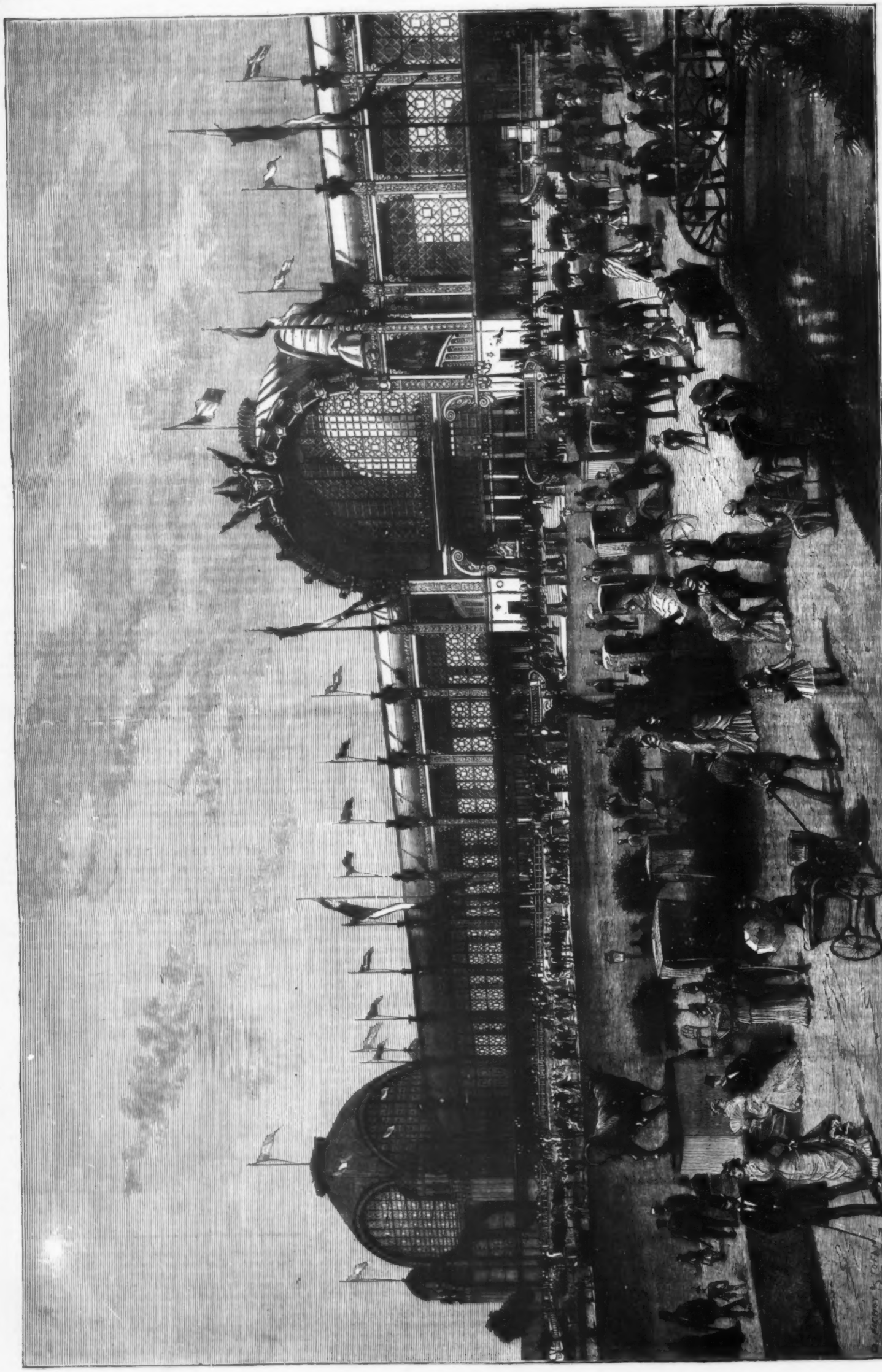
G. MARIÉ,
L'Ingénieur Attaché au Service du Matériel.
Paris, December 10th, 1877.

IMPROVED CRUCIBLE FURNACE.

THE annexed woodcut illustrates a very useful brass foundry appliance recently brought out by the Patent Plumbago Crucible Company, of Battersea, Eng. Partly in section, it shows the construction of Fletcher's annular hot-air furnace, applicable, of course, to melting various substances, but its principal use will be in the brass foundry. Air is admitted through the double pipe as indicated by the arrows, and after circulating through the annular chamber



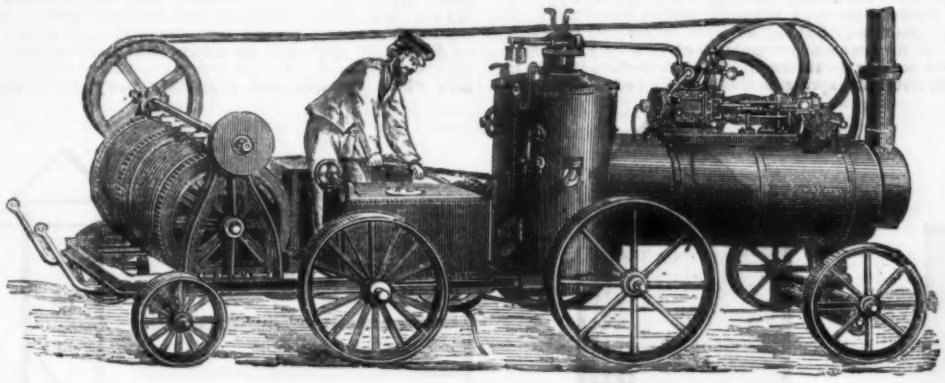
surrounding the lining, F, passes through the fire and out at the flue shown. Fire bars are dispensed with, and in their place a hinged dish bottom is employed, which not only secures economy in fuel, but forms a pan in which the metal is caught and saved without loss, and in a convenient form, when a crucible breaks. The furnace is self-contained and simple, and from the reports of the working of many of them in different places, and especially from some experiments made at Messrs. Mather & Platt's works, we learn that it is very economical in fuel, and remarkably so in time.—*Engineer.*



THE PARIS EXHIBITION.—THE PRINCIPAL FACADE AND THE PARK OF THE CHAMP DE MARS.

STEAM PLOW WINDLASS TENDER.

OUR engraving shows the Cheneral Windlass Tender exhibited at Paris by Messrs. Howard & Co., in connection with other apparatus for steam plowing. This is considered by the makers as a very simple and effective mechanism for winding the wire cables used in drawing the plows back and forth across the fields.



STEAM PLOW WINDLASS TENDER.

WATER SUPPLY.

By JOSEPH PRESTWICH, F.R.S., Professor of Geology in the University of Oxford.

THE water supply, as it now exists, whether of detached houses, villages, or towns, has been one of purely local growth, and although the sites of most of our older villages and towns have been determined by the presence of an easily accessible water supply, such as may be obtained by shallow wells or from rivers, very little improvement, and that only in the case of our larger towns, has been introduced in the sources of supply, notwithstanding that in the mode of distribution of the supplies in large towns England has distanced all other countries. With the increase of population, the simple contrivances that were originally in use have otherwise in most cases experienced but little change, although our buildings may have become crowded upon one another to an inconvenient extent, and have produced evils of the most serious character. Water-bearing strata—whether consisting of beds of gravel overlying clays, such as the gravel on which London stands, or of the outcropping beds of a deep-seated formation, such as the lower tertiary sands under the London clay, or of hills of permeable strata, such as the chalk or oolite ranges—while they absorb and store the rain water which they deliver again in the form of springs, absorb with equal readiness water from any other sources—consequently, what apparently more convenient in constructing a house than to sink a well in one part of the premises for water and on another part for the house sewage? The works are out of sight; no one thinks of the evil, and few realize it if they see it. But the evil is an accumulative one, and every now and then we are reminded of its existence by disastrous and fatal results. It has grown to such an extent that almost all the shallower of these sources of water supply are contaminated and injured, and our villages and smaller towns are suffering to an extent which it is difficult to estimate, and which few probably, except geologists, can fully realize. Not but that the other sources of supply—our rivers—have been treated with equal disregard of sanitary principles, and they would, but for timely Parliamentary interference, have suffered equally in consequence. The able sixth report of the Rivers Pollution Commission illustrates in a remarkable manner the consequence of this neglect, whether in the case of our wells or of our rivers.

I have prefaced my communication with these few remarks, because, in considering the general question of water supply, it is as indispensable to determine what source should be avoided as it is to see what sources are available, and in what way the mistakes of the past may be avoided for the future. Fortunately natural agencies are constantly operating to counteract the evil consequences of our neglect. The power of oxidation and absorption of the soil on underground waters, and of air and light on surface waters, goes far to remedy the evil and restore our springs and rivers to their original purity. The surface waters have been the subject of successful legislative enactment, and it is to be hoped that some similar measure may be applied to our underground waters, for nothing else, it seems to me, can effect a cure for an evil which is so widespread, and at the same time so entirely withdrawn from observation. The arrangements being all below ground, are unknown in most instances to all except the builder, and the well springs, although often seriously contaminated, yield too often water which is so cool, limpid, and sparkling as to not only give confidence to the resident, but even to inspire him with a belief in its unusual excellence.

In our larger towns, where cesspits are gradually being done away with, the wells may improve if no other source of impurity exists; but in villages and detached houses, where nothing is done, not only do the local underground springs suffer, but it is to be feared the pollution often injures sources having a wider range. Some contrivance for the protection against the contamination of underground waters, used in common by adjacent communities, is as much needed as party walls are as a protection against the spread of one's neighbor's fires.

If this were done many of the underground springs which of old supplied both town and rural population might be again rendered available for their use, and it would not be necessary to look for a supply to more distant and less accessible sources. It must be, however, remembered that none of our several sources of public supply are free from some drawbacks.

The gravitation system is very good where there are large tracts of high ground not under cultivation, but with the decrease of these and the increase of population the difficulties in the use of this plan are yearly increasing. The variability of our rainfall forms also an objection.

Rivers offer a source generally available, as their waters consist of the immediate rainfall, flowing at once from the impermeable portions of each hydrographical basin, and of the springs due to past rainfalls, discharged in the same basin, throughout longer periods of time, from the permeable strata—but for the many contaminations to which they have too frequently been subjected. With the remedies, however, now in operation against river pollution, and the well-known purifying effects of flow and aeration, our rivers still frequently offer convenient and large sources of supply.

Springs afford supplies, generally good in quality, but more limited in quantity. Instead of being absorbed in our rivers, the risks incurred in their channels are avoided when the springs can be at once diverted and stored for use. Where they are sufficient there cannot be a better source.

Deep wells may be either ordinary ones—sunk in an area where the permeable strata extend from the surface to considerable depths, as in the case of our chalk downs or oolite hills—or may be artesian wells, when the same permeable strata pass beneath impermeable strata, and can only be reached by passing through the latter, when the water rises in the bore, or shaft, to its natural level, which may be above the surface, or may be at some depth intermediate between the surface and the imprisoned spring; in any case it may be assumed to rise to a considerable height above its original level.

An impression prevails that, owing to the extent of filtration experienced by the surface waters in passing through a great thickness of such permeable strata, it becomes purified more effectually than it can be by any other means. To a certain extent this is true, but these strata are, nevertheless, exposed to the same dangers as are the river waters, only the sources of contamination fail to make themselves so apparent, nor do they exist to the same amount. They are, nevertheless, there, although from being less conspicuous, they have not attracted so much attention. Thus, in constructing a house on the sand hills of Sussex or the chalk hills of Kent or Surrey, it is the almost invariable practice to dig a shaft more or less deep into which the house sewage and surface waters are directed, and from which they disperse rapidly and disappear in the mass of permeable strata, as in a filter. Neither builder nor tenant may know or inquire what becomes of all this fluid refuse. But it is, of course, not lost. It passes underground, and goes to increase the reservoir of underground water stored away in the body of the hills. The population on these hills is, owing to the depth at which the water lies, usually sparse and scanty, so that the evil is at its minimum. Still it exists, and is increasing, while manufactories, cemeteries, and increasing cultivation contribute their inevitable quota. It is not difficult, therefore, to account for the presence of nitrites and nitrates found in our chalk and oolite waters, although it must be at the same time observed that the extent of filtration breaks up and destroys almost all the original organic matter. Yet so it is in our rivers where the flow (as in the other case the filtration) is of sufficient length.

But there is another and more serious evil to guard against in some underground waters, and this is the consequences to be feared from blind wells communicating with the springs. These wells are formed where the underground spring does not rise to the surface, but stands at a depth of 50, or 100, or more feet. Then any addition made to the spring does not affect the level, or only temporarily, of the water in the well, but goes to feed the volume of the spring. This may go on for years, the impure water passing below ground, and forming a constituent part of the spring. Such wells form natural drains of a most permanent kind, because, as the underground spring cannot rise in the well so long as the other channels of escape by which its surplus waters have been hitherto discharged remain open, every addition to it only increases the volume of the spring. This plan was formerly so largely adopted in Paris that the waters of many wells there were rendered entirely unfit for use. It is to be feared that London and its neighborhood are not free from them. Those with whom it originates are, I imagine, often not aware of the consequences. I have not made this the subject of any special inquiry; but looking at the facilities this plan offers for ready and inexpensive drainage, I have reason to believe that these blind wells may not be uncommon, whether in the chalk or in the lower tertiary sands under the London clay. Incidentally, two cases have come to my knowledge which will serve as illustrations

Some time ago it was in contemplation to construct such a dry well for drainage purposes a few miles from London. I happened to be consulted and pointed out the objections, but whether or not the work was carried out I do not know. The other case is, if rightly reported, a most objectionable one. A cemetery near London stands on a bed of gravel; under the gravel is the London clay, and beneath the London clay are the water-bearing lower tertiary sands which hold the springs supplying the greater number of artesian wells in London. I am informed that, in order to carry off the water from the gravel in which the graves are dug, a dry or blind well was sunk through the London clay into the underlying sands, and that into this well the drainage of the cemetery is diverted. Although the filtration through the sands will remove much, or, if the distance be sufficient, possibly all of the organic matter carried in by such refuse waters, still such a proceeding cannot be otherwise than most objectionable and obnoxious, and serves to show how our wells may be polluted as clearly as in the instances of the more conspicuous pollution of our rivers.

In fact, with our present arrangements, and with the distribution of our population, the purity of our water sources is only a question of degree. Although nature steps in and is incessantly at work in remedying rapidly and effectually much of the evil, there are limits to this self-acting process, and while, on the one hand, the fixity of the rainfall insures that the measure of our future will not exceed those of the present sources, the calls on those sources must steadily increase, and if care be not taken there will, with the increase of population, be a proportionate increase of contamination. But this care, for the reasons before mentioned, cannot be exercised by individual action. Self-interest and incompetency are alike opposed to any such expectation. It can only be done by legislative measures, of which we have had a commencement in the Rivers Pollution Bill. Some similar measure of protection is equally needed for our underground waters and our springs.

Let us now briefly consider how our sources of water supply are derived. There is the rainfall stored in lakes; there is the rainfall stored in hills and at depths beneath the surface; and there is the rainfall carried off by rivers and coming to the surface again as springs from the overcharged hills.

Lakes.—In imitation of these natural reservoirs we have the artificial reservoirs of drainage areas to which we have before alluded. The objections which apply to the latter do not, however, apply to the former. Lakes in this country only exist where the rainfall is exceptionally great, where the land is high, the rocks hard and in great part bare, and where the population is scanty and never likely to be very numerous. Such districts, therefore, possess large, steady, and pure water stores, vastly in excess of the needs of the local population, and offer to the teeming populations of adjacent lower lying districts the most valuable boon of their surplus stores. I consider, therefore, that in a national point of view, for the supply of our manufacturing and large commercial towns, where the population has outrun from its numbers, or overrun with its impurities, the ordinary supplies of the hydrographical basin in which they are situated, the waters of these lakes, if fairly and economically used, and with due local considerations, present legitimate and most valuable sources of water supply.

Wells.—Another source of supply lies in the water stored in our hills and at depths beneath our valleys. The annual surplus escapes as springs, to which I will refer presently. That which remains underground is obtained either by deep and artesian wells or by shallow wells. The deep wells are especially valuable in chalk, oolitic, or triassic districts, where the mass of the strata is great and the water stores proportionately large, and in those districts of England where these formations exist they may often afford excellent sources of supply, though care is required, that as far as possible only the waste and surplus quantity is taken, as otherwise the neighboring springs and wells must unavoidably suffer.

Artesian Wells can often be used with great advantage. As the outcrop of the strata supplying them is sometimes at a very considerable distance from the towns they supply, they may conduct water from districts where it can be spared to others where there is a deficiency. At the same time, the extent of strata through which the underground water passes, and the depth beneath the surface, insure the most perfect filtration and uniformity of temperature. The Chalk where it extends under London acts in this way. But as the water does not pass with great facility, and the drain on it is excessive, the level of the underground water diminishes, as is well known, from year to year, and stands now many feet below its normal level. In such a case as this there is a risk to the quality of the water, for under the original normal conditions the surplus underground water due to the annual rainfall escapes through various channels at the lowest levels, especially in beds of rivers or the sea shore; but when the water line falls, through artificial interference, beneath these surface levels, the pressure is reversed, and an inflow is established which inevitably carries in the outer waters (before the receiving medium) to supply the deficiency, and if those waters be impure, the springs must suffer. In all these cases the original natural balance cannot be disturbed without introducing complications which are difficult to foresee.

The Oolites and the Triassic rocks of the midland counties, where they pass under impermeable strata, also lend themselves to the formation of Artesian wells, as do likewise beds of sand when sufficiently thick. On a small scale, the Lower Tertiary sands have for some years past been made available for this purpose; but their dimensions are very limited, and the demand on them too large. There exists, however, at greater depths beneath the Chalk, the Lower Greensand, which, as I have long pointed out,* would in all probability, as it does at Paris, be found to contain large stores of water. There is, however, the possible contingency of iron being present; for although most of the Greensand water, both in wells† and at its outcrop, is of excellent quality, there are other wells where the water is slightly ferruginous. This can only be determined by experiment. The anticipation first formed of the continuation underground of the Lower Greensand from Kent and Surrey to Buckinghamshire, proved incorrect, as it was found to be interrupted by an underground ridge of Palæozoic rocks. But the boring recently made at Messrs. Meux & Co.'s brewery has shown this formation to extend northward as far as that point, so that in the area between South London and the Chalk hills of Kent and Surrey, the Greensand, which varies between these points from 60 to 500 feet thick, would, no doubt, be found in sufficient development to yield a large quantity of water, and might prove to be a source of considerable value for public metropolitan purposes. But whatever the quantity, both quantity and quality must inevitably suffer if the source be open to unrestricted use. For whether with the waters stored in our hills or at depths beneath the surface, it must be borne in mind that all the surplus quantity (which is that due to the annual rainfall) escapes naturally in the form of surface springs, except the very small proportion that escapes below the high water mark, in our estuaries, and on our shores, where the permeable strata run out to sea. At a distance from the coast this action is reduced to a vanishing point. How far, therefore, these underground waters can be drawn on without injury, depends on local conditions of population, surplus quantities, etc., which must be determined separately for each case, but it is necessary to observe that while you may depend on the quantity yielded by the annual rain-supply, you can no more overdraw the water-capital of these hills without a resulting deficiency in the course of years, than you could expect to maintain income while drawing annually on capital. Both must end in bankruptcy.

I have already mentioned that these sources of supply are not, any more than rivers, altogether free from pollution, but

* "The Water-bearing Strata around London." Van Voorst.

† The two deep Artesian wells at Paris yield water of great purity, and valuable as an auxiliary source of supply.

the extent of filtration where the permeable strata are thick, as in the Chalk, the Lower Greensand, the Oolites, and Trias, reduces the mischief to its minimum. It becomes more objectionable when the strata pass at depths beneath the surface, and the water can only escape by artificial means, and, therefore, in much smaller quantities. Still, as a rule, these waters are good and wholesome, and where the underground reservoirs are so extensive that their use does not interfere with local supplies, or with the permanence of streams, they offer convenient sources of supply, which, if moderate in quantity compared to lakes and rivers, are often available when the latter are not.

Shallow Wells, 10 to 20 feet deep, are very general in thin permeable strata overlying beds of clay. These, from their small dimensions, contain only limited quantities of water, and are affected, therefore, by a less quantity of impure admixture. But from the circumstance of being of easy attainment, inexpensive, and at every door, they are in more general use than any other source for private supply, where the quantity of water required for each house is small. For the same reason such sites were early selected, and have been in use for ages. Shallow wells consequently exist everywhere where beds of gravel or thin beds of sand overlie clays, that is to say, in places all over England, on high grounds and on low grounds, as well as in valleys where the line of water level is, from other causes, within easy reach of the surface. It is this facility of obtaining water on the one hand, and of drainage on the other, in shallow water-bearing strata, that has led to the pollution of the water I have before pointed out.

While every house or every village has found in the permeable stratum its ready water supply, each one has also found its convenient pit for the drainage of all house sewage. Graveyards, manufactories, and other sources of organic impurities in the same way drain into the common spring underground, and contribute to the general mischief. It is only surprising that the consequences are not more serious. Few houses, whatever their character and importance, are, under these geological conditions of water-supply, free from this lurking and insidious evil, which is, probably, more than any other the frequent cause of illness and disease (though often in a form not to attract attention for years), in towns and villages which would and should otherwise, from their position and build, be chosen for healthiness and cleanliness. For this reason good surface springs, or some good selected source for common supply, would prove of much importance to our smaller town and villages. For detached houses it is difficult to see what remedial measures can be applied, except better knowledge on the part of builders or adherence to obligatory rules.

Springs.—If left to itself, all the surplus rain supply stored in the hills escapes as springs; and these, although small compared with rivers and lakes, form very valuable supplies where the strata are of sufficient dimensions to afford extensive filtration, and maintain a permanent and large delivery. They have the advantage over wells in that they are natural water channels, enlarged by time, and from which all the more readily soluble matter has been removed by long wear. When, therefore, such sources of supply are available, they are among the best and most desirable that can be adopted, although their volume is generally such as to limit their use to villages, or to towns of moderate size. As an illustration of this source of supply, there are the fine springs of the Oolite hills in the upper part of the Thames basin, which I have pointed out for the water supply of Oxford,* or which might, together with the great Chalk springs of the lower part of the same valley, be made available, as a potable water, for the use of London.

The value of a pure water supply is so inestimable that, except on the score of cost and inconvenience, I see no reason why a separate supply of potable water from this or other sources should not be introduced into our large towns, as has been already proposed for London, where the water requirement for ordinary purposes is so vast, and the difficulty of filtration so great, and becoming year by year more unmanageable. Springs of moderate volume exist in most parts of the country. The chief of these in the Oolite and Chalk districts of the Thames valley will be seen on the hydrogeological map I prepared some years since, with contour lines furnished by the late Sir Henry James, to accompany the report of the Water Commission, but which, though printed, has never been published. An inspection of this map will show how numerous are these springs in the Thames basin, while the sections across the same basin show how large the volume of water stored in the hills is, and what portion of it goes to form the perennial springs, or may be drawn upon by deep wells. It will be noticed that one set of springs is dependent upon a lesser head of water than others, and that from the geological structure of the country, it is not difficult to determine to which order any spring may belong. The villages and towns which might be supplied by these means are many, and no better supply could be desired, even if it were limited only to the supply of drinking water.

Rivers.—With respect to this more ordinary mode of public supply, it is a sound principle laid down by the Water Commission of 1869, that each river catchment basin should supply, as far as possible, its own population. There are cases, however, where the population of one basin being much under its amount of water supply, no inconvenience could arise in diverting a portion of the surplus supply from any source to places in adjoining basins, where the population is in excess. So long, however, as this does not happen, and the river waters are maintained in a state of sufficient purity, so long should the towns in each catchment basin look to the rivers and springs in that basin for their sources of supply. Under the improved system now inaugurated, it is to be hoped that many, if not most, of our rivers may be rendered (if they are not so already) available for the water supply of the towns on their banks. This subject is so fully treated in the report of that Commission, on which I had the honor to serve, that I need say no more about it. Nor do I think it necessary to go into the question of hard or soft water which the Commission also fully discussed. The conclusion I drew was, that it was really a matter of very minor importance, compared to the great importance of freedom from organic matter. Both waters, avoiding extremes, are perfectly wholesome, and as a question of preference, it seems to be very much one of use and custom. Pure lake waters do not seem, as a question of health, to be better than pure chalk waters, or pure river waters.

Rivers subject to floods should store a portion of their flood waters, and so better regulate their delivery during dry seasons. Their volume, however, depends not only on the rainfall, but on the geological character of their catchment basins, a subject which will also be found fully investigated with respect to the Thames and the Severn in the report of the same Commission. As an admirable instance of the study of the *régime* of rivers and of water supply to towns, I would refer to the late M. Belgrand's hydrological and geological map of the catchment basin of the Seine, with its accompanying tables and report.

In the foregoing remarks, I have merely attempted to give general outlines of where our towns and villages may look for their water supplies, and to point out, also generally, the risks run of organic contamination in the different sources of supply. A careful selection of the one, and the application of proper restrictions to the other, cannot but be a matter of the highest importance, requiring the most careful consideration. It is not possible, in a communication of this kind, to go into the details of particular districts. Each one must be the subject of special inquiry, with respect to various conditions, of which that of geological structure is one of the most essential, whether as regard the sources that should be chosen as well as those which should be avoided. The existing evils arising from contamination are so serious that the probability of this has, in each case, to be considered, and a remedy, where needed, applied. This is a matter of considerable difficulty, as without some knowledge of geology and chemistry, it is not easy for those whom it is intended to relieve to see or understand the necessity for change, especially where the polluted waters are, as is so often the case, cool, sparkling, and pleasant, and where, further, the change involves cost and trouble. Authority is needed in such instances to effect changes which are indispensable, or to carry out a combined plan of public supply from new sources for the general benefit of the community. Much information on the subject is already furnished in the map of the geographical survey, in the Reports of Royal and Parliamentary Committees, in special works and papers, in scientific periodicals, and in the Reports to the British Association.—*Journal of the Society of Arts.*

* "On the Water Supply to Houses and Towns, with Special Reference to the Town of Oxford." Parker & Co.

A SINGULARLY FATAL OCCUPATION.

THE statement has been made by a Sheffield (England) physician, that the fork grinders' employment is probably more fatal to human life than any other pursuit in England. According to this authority there are generally from eight to ten individuals at work in the room in which this industry is carried on; and the dust which is created, composed of fine particles of stone and metal—the grinding being always performed on dry stone—rises in clouds, and pervades the atmosphere to which the operatives are confined. The dust, which is thus every moment inhaled, gradually undermines the vigor of the constitution, and produces permanent disease of the lungs, accompanied by difficulty of breathing, cough, and a wasting of the animal frame, often at the early age of twenty-five; and the average longevity of fork grinders is found not to exceed thirty years.

THE man who was put in sudden possession of $2,500,000 by the discovery of petroleum on his otherwise almost worthless Pennsylvania farm, only to become poor again through wild extravagance, is now a station agent on the Atlantic and Great Western Railroad.

STEAMING PRINTED TEXTILES.

THE Industrial Society of Rouen recently offered a prize "For the best work on the steaming of printed textile fabrics, especially cotton, comprising the historical part of the question, the study of the part which vaporization plays in the fixing of the colors, the description with drawings of the apparatus used, and an indication of the progress to be attained." The committee appointed to examine the pamphlets submitted, selected one which, they say, although it did not fulfill all the conditions and expressed theories not commonly received, nevertheless contained such merits in its descriptive parts that the author was fairly entitled to the reward offered. As the committee was composed of men whose opinions and experience carry considerable weight, we translate that part of the pamphlet which was commended, and which treats of the different appliances in use for steaming textile fabrics.

En passant, we may remark that this mode of fixing printed colors is of comparatively recent date, and, consequently, of more interest than other methods. As is well known, the colors are printed upon tissues or yarn in the ordinary way, and the color thus applied "fixed" by the application of steam; the points to be observed in practice being three, viz., to fix the colors with the greatest possible fastness, to accomplish this economically, and with the least consumption of time.

Fig. 1.

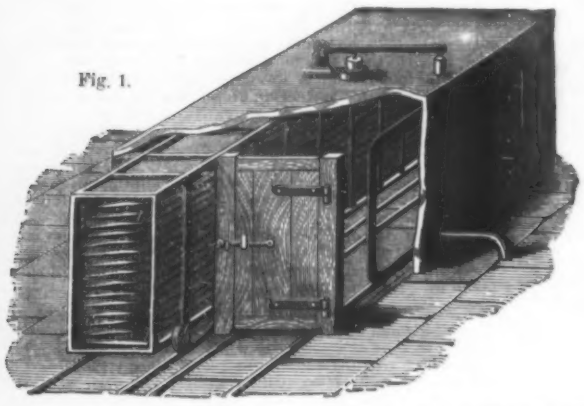


Fig. 2.

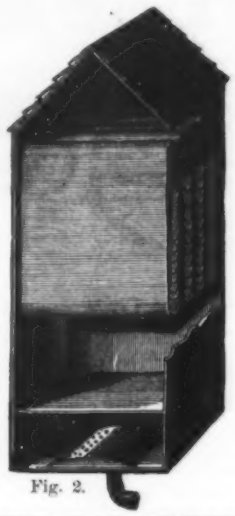
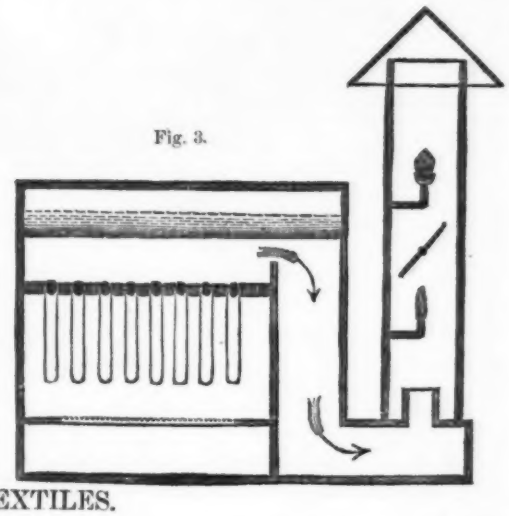


Fig. 3.



STEAMING APPARATUS FOR PRINTED TEXTILES.

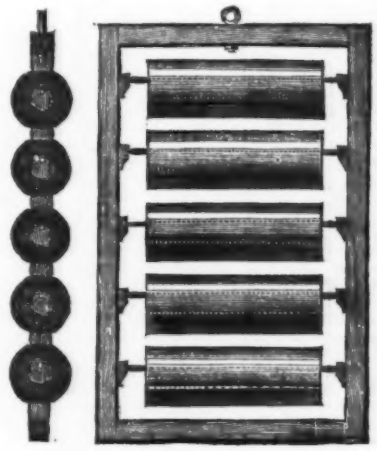


Fig. 4.

The first contrivances in use for the purpose of steaming fabrics consisted of a chamber into which the printed pieces were hung upon rollers, and subsequently of a perforated steam-pipe, upon which the cloth was rolled with a blanket; these, however, have long since been abandoned as being too tedious, and not accurate enough for the present perfected state of the printer's business.

The first apparatus introduced of any value is a chamber containing frames, as represented in Fig. 1. It has a length of about 4 yards, a width of 3 yards, and is closed at one end by a pair of doors, through which the frames are admitted. These frames run in upon wheels and rails; they are of a size to fit the interior of the chamber, and the cloth is stretched upon them by being hooked on with its selvages, so as to get the greatest possible length into the space: thus, a chamber of the dimensions given will contain from 600 to 650 yards of cloth. In order to distribute the steam evenly it is introduced by two pipes, closed at their extremities, but containing a number of very small holes. As the space in the interior of the chamber is large, and condensation of the steam might take place, which, if not provided against, through the dropping of the water, would spoil the goods, it is necessary to cover the frames with a hood of cloth, which is an effectual protection from the dripping water.

One of the most usual methods of steaming is to suspend the cloth in a chamber, as shown in Fig. 2. This plan admits of a great many modifications. The chamber consists of a rectangular room or box made of wood, iron, or cemented bricks, but in each case perfectly tight; on the bottom are placed pipes perforated with small holes, which give access to the steam. The chamber is generally two or three yards long, the same height, a yard or a yard and a half wide; the inner walls are lined with coarse linen or cotton cloth, and to prevent the water carried by the steam from injuring the pieces to be steamed, there is a false bottom of cloth (linen, cotton, or wool), which dries the steam. The pieces to be steamed are rolled with a blanket to prevent creasing, and then suspended from a hollow roller resting upon an iron bar which is fixed to a rail on each side of the

chamber. A dozen are generally suspended at a time. In order to obtain a uniform action upon all parts of the pieces, it is necessary to change their position occasionally; for this purpose there are pinions on the ends of the iron rods which gear one into another, so that by turning one of them by means of an outer handle the whole series of pinions are likewise turned, and the pieces therefore moved. When all the pieces are placed, the chamber is covered by a cloth, or a cover, or even by a hood, which allows the steam to escape out of the chamber; sometimes the upper part is covered by an iron frame upon which a cloth is stretched, and which is screwed down entirely steam-tight. As soon as the steam is admitted the false bottom of cloth assumes a more or less convex form, in proportion as the pressure is higher or lower. A steam-pipe communicates with a gauge placed outside, which indicates the degree of pressure.

In places where the steam condenses easily, it is considered best to give the chamber the construction shown in Fig. 3, page 2274; it is then covered with a tight-fitting lid, and at one end a wooden shaft attached, in which burn one or two gaslights in order to create a draught: in this manner the steam is kept dry and conveyed from the room.

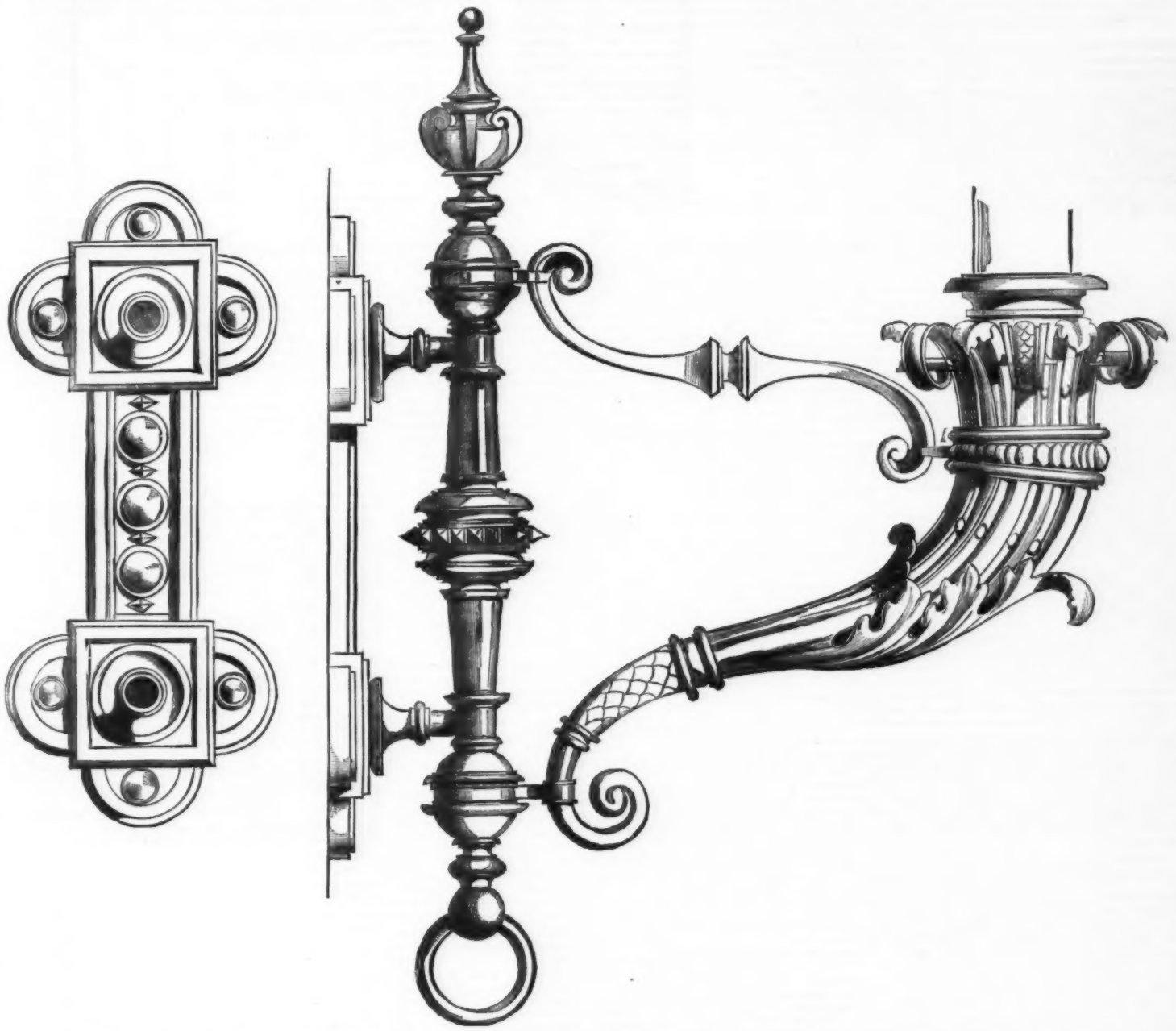
Another modification in the construction of this chamber is to surmount it with a hollow iron cover which contains steam; the object of this is to prevent condensation on and dropping from the underside of the cover. The rack carrying the hollow rollers may also be made to roll in and out upon wheels, so that the whole may be charged outside, and then wheeled in; thus a frameful may always be ready, and more work turned out with one chamber. In place of the rolls of cloth, the latter is sometimes also hooked upon frames such as are used for indigo dyeing; this has the advantage of entirely preventing any damage by dropping, but is a slow process, and therefore only resorted to in special cases. This frame is too well known to require any further description.

Moleskins are sometimes steamed under high pressure in a similar chamber, or rather boiler, which has to sustain a pressure of 45 to 60 lbs. The condensed water is then carried off by a pipe placed at the bottom. The doors through which the frame containing the rolls of pieces are admitted are made steam-tight by means of India-rubber rings upon which they close. An important addition to this apparatus is an air-valve, which must be opened when it is intended to cool the chamber, otherwise the doors could not be opened on account of the external pressure.

Richards' chamber is illustrated in Fig. 4. The peculiarity of this is the manner of suspending the pieces; instead of being hung in the form of sacks, as shown in Fig. 2, they are here rolled upon a copper shell of about ⅛ inch thickness, perforated with small holes. These shells have an inside diameter of about 5 inches, and the cloth is rolled upon them tightly, so as to form rolls of 12 to 13 inches diameter. In this way much space is saved, because 25 pieces can be placed where only eight or nine have room if hung in the former sacks. The chamber is here supposed to be one about 3 yards high above the false bottom, 2½ yards long, and 1½ yard wide; the sides contain grooves, into which iron frames can be slided and lifted out from above. Five such frames, each containing five pieces, give a charge of twenty-five pieces. In other respects this chamber is like the previous ones. It is evident that though space, and, consequently, steam are saved, the result may be unsatisfactory on account of the tightness of the rolling, which must prevent the steam penetrating with the same ease as in the previously mentioned arrangements.—*Textile Manufacturer.*

GREEN ON COTTON WARPS.

THE wool is first carefully dyed. Not to injure and burn the cotton fiber the dose of sulphuric acid generally employed is diminished, taking for 11 pounds of goods—Sulphate of soda, 26 ozs.; sulphuric acid, 5¼ ozs.; extract of indigo, 8¾ ozs.; turmeric, 7 ozs. Having thus obtained a green which may be modified to the exact shade required by the addition of more or less extract of indigo or turmeric, a second beck is prepared with—Sumac, 2¼ lbs.; fustic, 10½ ozs. The garments are worked in this beck for two hours, drained, and finally cotton dyed to shade in a water, to which the clear solution of ¾ oz. to 1 oz. methyl green has been added. If necessary a little logwood may be added to the green bath to darken the color.—*La Teinturier Pratique.*



SUGGESTIONS IN DECORATIVE ART.—BRACKET PIANO CANDLESTICK.—*From the Workshop.*

BRACKET PIANO CANDLESTICK, DESIGNED BY IHNE & STEGMULLER, BERLIN.

THE material of this bracket is plain yellow or red brass, with a galvanoplastic coating of nickel or brass, or in richer execution of silver, parcel gilt. The motive of the cornucopia serving to receive the light is not uncommon; it is met with as a wrought-iron torch-bearer in the court of the Bargello Museum, in Florence.—*The Workshop.*

AMERICAN COMPETITION WITH ENGLAND.

IN a discussion of the prospects of English manufactures, the London *Economist* comes to the comfortable conclusion that little is to be feared from the rest of Europe. In the United States, however, it goes on to say, the conditions of industrial production have undergone such a considerable change in the last five years that possibly that country is about to become our most formidable rival. Political economists have often pointed out that the inability of America to compete with Europe in manufacturing has been due, not to the greater cost of the raw material, which in some cases she obtains more cheaply, but because capital and labor have hitherto commanded a higher remuneration on the other side of the Atlantic. This discrepancy scarcely exists at present. Since the war capital has accumulated to an extent previously unknown. The effect of this accumulation was concealed for some years by a speculative expansion of trade and the general inflation of prices caused by a paper currency. But the inevitable contraction has followed, and capital is now compelled to accept a rate of interest little if at all above our standard. The decline in the price of labor since the crisis of 1873 has been still more remarkable. For the first time in the history of the United States skilled labor only commands the English scale of wages, and in some cases has fallen even lower. It seems not unlikely that American competition will be especially felt in our two leading industries—cotton and iron. In the first the American manufacturer starts with a slight advantage in the cost of the raw material, the freight from the Southern plantations to the mills in New England being somewhat less than to Liverpool. This, however, is balanced by the superior fitness of our climate for spinning, owing to its humidity. The cost of working the machinery is probably a far more important item. In New England the mills are principally run by water power, against steam in Lancashire, and the relative price at which this power is obtained will go far to decide which country can manufacture cotton the cheapest. At any rate, if the decision is in favor of steam, the American factories will have to be built in closer proximity to the coal fields than at present. The following are the values of cotton manufactures exported from the States in the year of the panic and for the last two seasons:

1873	£610,000
1876	1,540,000
1877	2,040,000

This increase was no doubt largely due to the inability of American manufacturers to get rid of their stocks at home, and the goods may have been sold at a heavy loss, but future developments deserve to be carefully watched. The United States possess no special advantages in the production of iron, and, notwithstanding the fall in labor and capital, it is doubtful if they can yet compete with us in cheapness of production. When we hear of Americans taking contracts for locomotives at prices which English makers are compelled to decline, it is manifestly not a question of the cost

of the raw material, or they would be underselling us in pig iron and rails rather than in manufactures of the highest quality. The truth seems to be that the article supplied is better adapted to the wants of the buyer. Englishmen are too apt to conclude that what suits this country is adapted for all others. But it would be absurd to build and equip a line running through a thinly settled country, like the Western States or Russia or Brazil, in the same manner as a first-class English railway. In America a line is built cheaply, with steep gradients and sharp curves. Their locomotives are less costly, because of lighter construction. The diminished weight lessens the wear and tear of both road and engine, while the strength of the latter is sufficient for the low rate of speed required. Moreover, the "bogie" truck on which they are built greatly lessens the friction in rounding sharp curves, and their engineers contend that there is more "give" in the general construction than in a stiffly-built English engine. There are many articles where a slight difference in price is of secondary consideration. In tools, for instance, the Americans surpass us in finish, lightness and poise, if not in quality of metal, and these are important requisites when working in a climate like Queensland or Brazil. The use of machinery is, in some departments, carried further in the States than here, but this advantage can be easily overtaken, and is of less moment than diligence in studying the special wants of our customers.

PHOTO-ELECTRIC ENGRAVING.

[THE following interesting process is extracted from a paper by Captain J. Waterhouse which appears in the Journal of the Asiatic Society of Bengal:]

Geymet's method of photo-engraving consists in electrotyping from a gelatine relief obtained by the pigment-printing process, and is somewhat similar in principle to Placet's process, but as there are important differences, and the process appears likely to prove of some utility, it may well be treated separately.

According to M. Geymet, who has very fully described the process and all the manipulations of preparing and electrotyping the reliefs in his "*Gravure Héliographique*," it was the invention of M. Audra, a French amateur.

Pigmented gelatine tissue is sensitized and exposed to light exactly in the manner heretofore described for the autotype process. It is transferred to a smooth glass or a polished copper plate, developed in warm water, and when dry is metallized and electrotyped. If the subject is one in line or dot only, the above operations are sufficient; but if the subject is a photograph from nature, or any other with gradation of shade, it is necessary to obtain a grain, and this M. Geymet does by taking a copper plate with its surface grained or engraved with a ruled or roulette tint, inking it up in the ordinary way, and then covering it with a coating of transfer collodion. When dry, the film of collodion is stripped off the plate, and carries with it the impression of the grain. This film is then placed between the cliché and the sensitive gelatine film, and serves to break up the shadows in the more transparent parts of the cliché.

A similar process has been used at the Depôt de la Guerre, in Belgium, for the reproduction of maps.*

Last year, while making some experiments on this process, I succeeded in obtaining the necessary grain by chemical means, which produce a finer and less artificial effect, and I have also made a few other modifications in the process, which may be worth recording at length.

A piece of the ordinary autotype tissue is sensitized in a five per cent. solution of bichromate of potash. When dry, it is exposed to light under a reversed negative, and then transferred in cold water to the surface of a well polished copper plate, and squeegeed down into close contact with it. In order to prevent subsequent adherence to the newly deposited copper in the electrotyping bath, the copper plate is silvered by rubbing it with a little of the following solution mixed with tripoli:

Nitrate of silver	1 part.
Cyanide of potassium	10 parts.
Water	100 "

The gelatine tissue attached to the copper plate is allowed to dry, and then developed in warm water in the usual manner, great care being taken not to loosen the lines, an accident which is very liable to happen, though the preliminary drying of the tissue before development tends to prevent it.

When the image is quite clear from all soluble gelatine, the plate is well drained, and plunged into a bath containing—

Tannin	5 parts.
Strong spirits of wine	100 "

This at once removes all moisture from the gelatine relief, hardens it, and gives it a fine grain, coarser in the shadows than in the lights. The plate remains a few minutes in this bath, till the action is complete in the deepest shadows; the tannin is then washed off with a little spirits of wine, and the plate is allowed to dry.

The gelatine relief has now to be prepared for receiving the electrotype deposit. A band of copper having been soldered to it, the back of the plate is coated with Brunswick black, to prevent deposition of the copper upon it. When the backing is dry, the margins of the picture are cleaned with a little of the silver solution. The gelatine surface then receives a very slight coating of wax dissolved in turpentine, which is well polished off, and is rubbed over with fine plumbago or silver-bronze powder to render the surface conducting. The plate is then ready to be placed in the depositing bath.

Any good electrotyping arrangement may be used, but I prefer a Smee's battery with a separate depositing trough, containing a solution of ten parts each of sulphate of copper and sulphuric acid in one hundred parts of water.

A plate of copper, to serve as an anode, and connected with the silver plate of the battery, is laid horizontally about an inch above the bottom of the depositing trough, which should be large enough to allow the plate bearing the gelatine relief to be slipped under the anode. The relief-plate is connected with the zinc plates of the battery, and, when everything else is ready the circuit is completed by slipping it into the depositing trough under the anode. By laying the plates horizontally in this manner the deposit is more even, and the gelatine film seems to be more readily covered with copper.

When the deposit of copper is of sufficient thickness it is separated from the matrix, and only requires a gentle "oil-rubbing" to be fit for printing.

The plates obtained by this method show very good half-tone with an almost imperceptible grain, giving the effect of a fine chalk-drawing.

I have lately tried to obtain the images upon the copper by the double transfer process, making use of a flexible temporary support, consisting of paper coated with India-rubber, as first proposed by Swan, which can easily be removed with benzole after the transfer of the gelatine image to the copper. The grain is given to the image by soaking it in water after the removal of the India-rubber paper, and then applying the solution of tannin in alcohol. This plan seems likely to be successful; if so, it will greatly simplify the operations, and enable engraved plates to be obtained from any ordinary negative without the trouble of reversing.

By electrotyping direct from the gelatine relief, the results are always rather heavier and coarser than they should be, because, although hardened and insoluble, the gelatine relief can always absorb a little of the copper solution in the depositing trough, and consequently the image swells and loses sharpness.

The strong tanning given to the gelatine film and the preliminary coating of wax before metallizing the surface obviate this defect to a considerable extent; but it may perhaps be better to obtain a matrix in lead by pressure from the gelatine relief, and then to obtain the printing plate by electrotyping twice from the lead matrix. This is a more roundabout and expensive method, but it is likely to yield finer results, and has been adopted by Woodbury and Rousselon in their processes.

The process is simple, and, if it could be successfully worked out, it might be usefully employed in this country in reproducing shaded maps and for other miscellaneous purposes. It has the very great advantage over photo-collotype that the plates can be corrected, if necessary, and can be printed in any numbers in the ordinary copper-plate press without risk of breakage or damage to the printing surface.

PRINTING SURFACES AND PICTURES BY PHOTOGRAPHY.*

By THOMAS BOLAS, ESQ., F.C.S.

Photo-Lithography and Photo-Zincography.—When a photographer wishes to take a picture, he, as a rule, begins by making what is technically known as a negative; this being a transparent picture having the lights and shades reversed. Now, here is a negative; as I hold it before the lime light you see that the parts corresponding to the dark portions of the original are transparent, and those parts which correspond to the lights of the original are opaque. Here, on the other hand, is a positive, or transparency, of the same subject as the negative which you have just seen; the lights and shades of this being as those of the object represented. A negative taken from nature should show the reverse of all those gradations of light and shade which characterize natural objects, while a negative taken from a line engraving or a page of letter press should show only two gradations, complete opacity and clear transparentness. Here is such a negative; and notwithstanding the fact that the opaque parts are not quite opaque to the sight, they are chemically opaque—that is to say, they will not allow the photographic rays to pass through. I have nothing to say to you regarding the making of negatives, as this matter belongs to photography proper, and not to our present subject.

Here is a sheet of paper which has been so prepared as to become darkened on exposure to light; let us place this behind our negative, and allow the light of burning magnesium to shine on the face of the negative. You see the result. Those parts of the paper which were covered by the transparent parts of the negative have become dark, while those parts which were protected from the light by the opaque parts of the negative retain their orginal white color. Thus a positive print is obtained on paper; but if the paper print be now exposed to daylight the whole will become dark, the picture, consequently, disappearing.

This operation illustrates the first phase in the process of photographic printing as usually practiced, the next step being that of unsensitizing the paper, so as to prevent the complete darkening which would otherwise ensue on the further exposure of the print to light. Our object now is to study the means of producing printing surfaces (plates or blocks) from which copies can be printed without the direct action of light being concerned in the production of each print.

The piece of paper which I now hold in my hand is sensitive to light, and I will place it under this negative of a line drawing and expose to the action of an intense light. You observe that a very faint brown image is now produced on the sensitive paper by the action of the light shining through the transparent parts of the negative; and I now hide this from your view by covering the face of the paper with a thin and uniform layer of printer's ink. For this purpose the ink is diluted with a little oil of turpentine, and applied by means of a dabber, made of the glue and treacle composition which typographic printers use for making ink rollers. The oil of turpentine soon evaporates, and leaves a compact and thin film of printer's ink on the paper. I next put the inked print into water, and leave it there while I tell you how the sensitive paper was prepared. A sheet of plain paper is first floated on this warm solution of gelatine (containing six per cent. of gelatine), and it is then hung up to dry (as I do now). When dry it is insensitive to light, and it may be kept any length of time without injury. To make it sensitive to light it is soaked for a few minutes in this solution of potassium bichromate, which contains about 3½ per cent. of the salt, and it is once more hung up to dry, but this time in a dark room, or in a room illuminated by yellow light. When dry it is ready for exposure under the negative.

Let us now return to the inked print which we left soaking in water, and try the effect of gently brushing the inked surface with a wet camel's hair brush. You see that the ink is gradually coming off, but in order to save time let us employ a little warm water, and, at the same time, continue to use the brush. Now the end of the matter is that the printer's ink becomes removed from all those parts of the paper which were not exposed to the action of light, and an image in fatty ink is thus obtained on the gelatinized paper. From this I now remove the excess of water by means of blotting paper, and lay the print, inked face downward, on a clean and slightly warm lithographic stone. The stone and paper being now passed through the press, you see that the paper adheres firmly to it, but on moistening the paper with a sponge it becomes easily removable. Now I strip it off, and you see that the fatty ink is fixed on the surface of the stone, leaving a perfect but reversed image thereon. Remember that this image consists of fatty printer's ink, and that it penetrates a short distance into the porous stone. Next, I put some thick gum water on the stone, and this also penetrates a short distance into those parts of the stone not already covered with printer's ink. I now rinse off the excess of gum and apply the inking roller; you see that the ink only adheres to those parts already inked; the gum parts resist the ink, and consequently remain white. A sheet of paper being now laid on the stone, I now pass the stone and paper through the press, and you see that I get an exact counterpart of the original fatty image (technically called a transfer) which was put down on the stone. Numerous copies may be printed from the stone by repeating the damping and inking.

You will recollect that when the light brown image was inked with printer's ink the ink covered the whole face of the paper; but when this inked image was put into water the ink became easily removable from the unexposed parts. Now gelatine which contains potassium bichromate undergoes a remarkable change when exposed to the action of light. It not only becomes brown in color, but it loses its property of swelling in water, and at the same time it refuses to be moistened; in fact, water rolls off it just as from a duck's back. Now, when the inked print (transfer) is put into water, the unexposed parts of the bichromated gelatine swell and loosen their hold on the fatty ink, while the exposed parts neither swell nor absorb water, but hold the ink firmly. In this dish are some uninked transfers, which have been soaked in water, and if you examine them closely you will be able to trace those parts of the gelatine which have swelled, leaving in each case a delicate *intaglio* image, or representation, of the negative employed.

Instead of putting the photo-lithographic transfer down on a lithographic stone, it may be put down on a zinc plate, and the plate can be printed from if treated exactly as the stone was treated. There are on the table some zinc plates and stones, with images transferred thereon, together with proofs from them; and there are also specimens illustrating the various phases of photo-lithography and zincography. Messrs. Whiteman & Bass, who have been most successful in the commercial practice of photo-lithography, have kindly lent me some very fine specimens of their work, which I am sure you will examine with much interest. There are also on the table some admirable specimens of work by Mr. Maurice Adams.

You understand that, in its usual form, photo-lithography is only adapted for the reproduction of the line subjects, or subjects in extreme black and white, and various attempts have been made to render it available for the reproduction of the gradations of a negative taken from nature. By a modification of Asser's starch process I have been enabled to get results which are at least encouraging. Here is a sheet of blotting paper, which I now cover with ordinary flour paste, containing 8 per cent. of flour. The paper having been coated, it is next smoothed with a soft badger brush, just as I am doing now, and when dry the paper is soaked in a 3½ per cent. solution potassium of bichromate, in order to make it sensitive to light. This piece of the sensitive paper being placed under a negative, and exposed to the light of burning magnesium for a few minutes, soon becomes tinted with a brown color where acted on by light, as you see. The light brown print is next soaked in cold water in order to remove the unaltered portion of the potassium bichromate, after which it is dried and ironed with a warm flatiron, just I am ironing this one. This last operation is to harden the coating. I now put the ironed print into water, take it out, lay it on blotting paper, and dab on printer's ink with a stiff brush. You see that the ink adheres to those parts where the bichromated paste has been made insoluble by the action of light, and it refuses to adhere to those parts where the paste remained unaltered. In this way a fatty transfer is obtained which, as you see by these examples, shows all gradations of a negative taken from nature, not, however, as a true half-tone, but as a grain or stipple well adapted for transferring to stone or zinc. As a fine image of this kind is liable to get clogged up when printed from stone, it is better to transfer it to a plate of zinc, and to make a typographic block from this by the method which I shall describe in a subsequent lecture. In the interval I will convert this zinc plate into a typographic block, and you will be able to compare these proofs, printed by the lithographic method, with others which I will take from the typographic block.

I hope some of you will experiment on Asser's process, with the view of improving it, as this method affords a promising field for work, it being specially adapted for large pictures.

Phototypic, or Raised Printing Blocks, by Swelled Gelatine Process, Zinc Etching, and other Methods.—Here is a fatty ink transfer, similar to that which I put down on a lithographic stone during the first lecture. I now lay it on a smooth and clean zinc plate and pass through the press. On removing the paper, by soaking, we find that the ink firmly adheres to the zinc, just as it previously did to the stone. A treatment with gum now protects the clear parts of the zinc plate against the adhesion of printing ink, and the application of the ink roller adds more ink to the fatty image already on the surface of the zinc plate. So far our present process resembles the photo-lithographic process described last week; but, instead of printing from the zinc plate, I dust powdered resin over it, in order to give firmness to the fatty image, very slightly warm the plate, and make the resin and ink partially blend, and then put it into dilute nitric acid, containing one part of acid to about forty parts of water, and here it remains for about three minutes, during which time the acid dissolves away those parts of the metal which are not covered by the waterproof coating. Now, let us take the plate out and examine it. We find that the covered parts stand slightly in relief, but only very little, and if we were to continue the etching without further preparation, the acid would gradually undermine the lines, and the image would be lost. Now, the undermining action of the acid can easily be prevented by washing the plate, drying it, and then heating it sufficiently to just melt the resin. Under these circumstances the melted resin blends with the printer's ink, and runs down over the sides of the little ridges left by the etching, and protects these sides from the further action of the acid. Having done this, it is well to gum the plate once more, ink again, dry and dust with resin before proceeding to another etching. This second etching may be done with stronger acid than the first, say one of nitric acid to thirty of water, and it may be continued longer, say for six or seven minutes, and when this second etching is finished the whole series of operations must be repeated until sufficient depth is obtained, care being taken that the melting of the resin is only carried far enough to allow it to flow just over the sides of the relief left by the previous etching. In ordinary cases ten etchings are enough to give the necessary depth, but in the case of important work it may be necessary to give twenty or thirty very slight etchings in order to obtain the same depth, without endangering very fine lines or details

* See Maes and Hannot, *Traité de Topographie*, etc., p. 330.

* Lectures delivered before the Society of Arts, London, 1878.

On the table are some zinc plates illustrating various stages of the process, and there are also some admirable specimens of finished work by Messrs. Leitch & Co. and by Messrs. Dellagana & Co.

The process of zinc etching has been largely employed for the production of typographic blocks from fatty transfers, either drawn by hand or printed, and this phase of the process bids fair to compete successfully with the art of wood engraving.

There are other methods of producing phototypic blocks, among which may be specially mentioned the method which is founded on the swelling of gelatine. These admirable phototypic blocks, which Mr. Dallas has lent me, are done by a method which he has perfected, but the nature of it has not been made public. Mr. Dallas was the first to introduce phototypic blocks into the English market, and if you carefully examine some of his specimens you cannot fail to be struck by the fineness and perfection of the details.

By the following modification of the swelled gelatine process I have succeeded in overcoming many of the difficulties of the methods already published.

We start with some clear sheet gelatine about one-thirtieth of an inch in thickness. This can be prepared by drying a layer of gelatine solution on a sheet of waxed glass, or it can be purchased from Mr. Cornelissen, of Great Queen street. To make this gelatine sensitive to light it is soaked in 3½ per cent. solution of potassium bichromate until it becomes flaccid, it is then laid on a piece of clean glass, and the excess of solution is removed by an application of the squeegee. The plate bearing the wet gelatine is then placed in a warm, and photographically dark, place to dry, and when dry it can be easily separated from the glass by raising one corner with a penknife. We obtain in this way a flat sheet of sensitive gelatine, having a smooth surface and all ready for exposure under the negative, and this exposure may last from 10 to 20 minutes in sunshine or a correspondingly longer time in the shade.

I now take the exposed film and put it into water to soak, and you will perceive that those parts which were protected from the light begin to swell immediately, while the exposed parts refuse to swell in the water. The soaking should last several hours, but as we cannot spare that time, I will take a gelatine which has already soaked the necessary time, and make a cast from that. For this purpose I lay the wet gelatine film on a piece of glass, exposed side upward, and squeegee it down as before; you see that it adheres to the glass quite easily, and after having made it surface-dry by dabbing with a soft cloth, a little oil is applied, and distributed over the surface. Now that the excess of oil has been removed by a soft cloth, I pour on plaster of Paris to a thickness of about an inch, taking care to remove any air bubbles by the application of a camel's hair brush through the liquid plaster.

Now, this plaster will take about ten minutes to become solid, so let us take another one, which was cast just before the lecture, and which is now set. If we violently tear the plaster and the gelatine apart the fine details of the cast are almost sure to be damaged. But instead of doing this, let us hold the glass plate in one hand and gently push the plaster cast with the other. Now you see that the gelatine is slowly sliding over the glass, and finally it will slide quite off, the plaster still being adherent to the gelatine. It is now merely necessary to turn up one corner of the gelatine film, and slowly fold it back so as to draw it off the plaster gently, and without fear of damage, either to the gelatine relief or the plaster, just as a lithographer draws a thin paper proof from the stone. The next step is to make a cast in stearine from the plaster, and for this purpose the plaster should be soaked in rather warm water, about 50° Centigrade, and on this soaked and warm plaster, just as I have it here, a layer of stearine about an inch thick should be cast. Such a cast takes a long time to cool, so I have provided myself with one previously done. There it is; see how easily the stearine separates from the plaster. I now dust the stearine cast over with bronze powder, the best being a kind specially manufactured by Mr. Allen, of Mansfield place, Kentishtown; and, this done, I put the cast into the electrotyping bath, and when a sufficient quantity of copper has been deposited it is merely necessary to back up with type metal and mount on a wood block, as in the case of this example, our work being then ready for the typographic press. If the process I have described is gone through with an ordinary half-tone negative an exceedingly beautiful electrotype is obtained, in which the gradations of light and shade are represented by varying degrees of relief. These, or even plaster casts, ought, I think, to have a very good sale, if photographers would only take the matter up. The ease with which they can be made is surprising.

I may mention that, instead of taking a cast from the plaster in stearine, gutta percha may be used, a press being employed to force the plaster cast—which should be in an iron chase—into the soft gutta percha. Here is a cast, and here a piece of soft gutta percha. I now put them into the press and apply pressure, and in a minute you will see what a good impression it is possible to get by this means. Of course electrotyping on the gutta percha is very easy, but the examples on the table will illustrate the matter sufficiently.

The depth of the relief obtainable by the swelled gelatine process is about equal to that of an ordinary visiting card, and where large surfaces of white occur it is necessary to deepen the plate in these parts. This may be done either by cutting out the metal from the finished plate, or, in most cases, more conveniently by raising the surface of the mould, let it be wax, stearine, or gutta percha, on which the electrotypic copper is to be deposited. This is best done by holding a stick of stearine or wax in the left hand and a warm pencil of metal in the other hand, and so holding the wax or stearine as to let a thin melted stream flow down the warm pencil. This stream is allow to flow on those parts of the mould which require raising.

Most commercial phototypers content themselves with producing a very slight relief by photography proper, and they then deepen by hand work.

Line Engraving on Metal Plates.—We now go back to the first photographic process discovered—that is to say, the first process which gave photographic representations which could be exposed to light without destruction—the bitumen process of the hard-working and patient Niépce. This investigator noticed that the residue left on the drying of certain varnishes became insoluble by exposure to light. About the year 1814 he covered metal plates with a bituminous varnish, exposed them in the camera obscura, and after exposure he subjected them to the action of similar solvents to those originally employed in making the varnish. Under these circumstances those parts of the film which had been exposed to strong light refused to dissolve, while the unexposed parts dissolved, a negative image being thus formed on the metal plate. To convert this negative image into a positive, those parts of the metal which were uncovered by bituminous matter were darkened by the vapor of iodine, and the bitumen was then removed by the use of a more powerful solvent. By the application of a suitable acid to bitumen pictures on metal the bare parts were dissolved away, and engraved plates were obtained.

Here is a specimen of bitumen or mineral pitch, a substance which is found in most quarters of the world. Let us powder a little, and pour benzole on it; you see that it dissolves quite easily, and the solution runs freely through this paper filter. You see that the solution is about as thick as collodion, or perhaps rather thinner. Now here is a carefully cleaned copper plate such as the engravers use, and you see that I am going to clamp it down on to this turntable. The next step is to flood the plate with bitumen solution, and then to make the table revolve quickly. Now it has revolved a few seconds, and I think the film will be dry. Here it is. I hand it round, so that you can judge for yourselves as to the advantages of this method of coating the plate.

I know of no other method by which such a uniform and compact film of bitumen can be obtained. After coating, it is well to put the plate aside for twelve hours, in order that the film may become harder. It is then necessary to dust it over with French chalk, to remove stickiness, and after this it is placed behind a transparency and exposed to light. The time of this exposure may vary from twenty minutes to two days.

Here is a plate which has had the requisite exposure, and the next matter is to dissolve away that portion of the bitumen which has not been made insoluble by the action of light. Now benzole is too energetic a solvent for my purpose, and oil of turpentine is not sufficiently active, but by mixing these together you can get any degree of solvent power which you may require. I will get Mr. Barker to treat this plate with the solvents. You see that he commences by flooding the plate with oil of turpentine, and, as this has not sufficient action, he pours it off and adds a little benzole. This begins to produce an effect, and enables him to judge as to the amount of benzole which he may safely add to the oil of turpentine.

He has added this quantity, and has now washed away all the soluble bitumen from the plate, which is next thoroughly rinsed with water to remove the oil of turpentine. You see how extremely sharp and well defined the lines are. I next place the plate in nitric acid, so as to etch the lines where the metal is bare, and while the etching is in progress, I will get Mr. Barker to dissolve away the soluble bitumen from this glass plate, when we shall find remaining the bituminous reproduction of a page of letter press, which I can show you by means of the lantern. Our first plate is now sufficiently etched, and when I have cleared off all the bitumen, by rubbing with a rag and benzole, the plate will be ready for the printer. It is now clean, and I will hand it round for you to examine.

Mr. Barker has now the bitumen image on the glass plate, ready for the lantern. The image is now on the screen, and you see how sharp and well defined the lines are. I take the plate out, and, if you examine it, you will notice that the letters are raised on the glass, they being, as you know, formed of insoluble bitumen. If we wish to etch the glass, it is merely necessary to expose it to the action of hydrofluoric acid, as I do now.

So much for the line-engraving process of Niépce; but before you go I want to show you that very perfect half-tone transparency pictures may be produced by means of bitumen. Here are some pieces of sheet gelatine and some pieces of talc which have been varnished on one side with bituminous varnish. I hold two of these, one being on talc and the other on gelatine, over against the lime light, and you merely see even films of bitumen, but no image. There is, however, in each case a picture of insoluble bitumen embedded in the films, and I will get Mr. Barker to dissolve away the soluble portions, so as to lay bare this hidden image. He will use a mixture of oil of turpentine and benzole as a solvent.

Supposing that the varnished side of the talc or gelatine is placed in contact with the negative, and the light is allowed to shine through it, those parts of the bitumen film which are under the perfectly transparent parts of the negative become insoluble, let us say, all through. Now those parts of the film which are under less transparent parts of the negative do not become insoluble all through, but a skin of insoluble bitumen is formed on the surface of the bitumen film, this skin varying in thickness according to the amount of light which has given rise to it. Put a varnished and exposed gelatine sheet of this kind into the solvents, and note the effect. When the film is made insoluble all through it resists the action and remains on the talc, but where only a skin of insoluble bitumen exists on the surface of the film, the solvents loosen and dissolve the bitumen from underneath this skin, and away it floats.

Now you can understand why the bitumen process, in its ordinary form, is only adapted for the reproduction of subjects in extreme black and white, such as line engravings or letter press. Now if we wish to preserve the half-tone picture intact, we must expose through the transparent medium (talc or gelatine) so as to insure every part of the insoluble image, whatever its thickness, being in contact with the transparent support. Those prints which Mr. Barker is developing were done in this way, the talc or gelatine being placed in contact with the negative. The small thickness of talc or gelatine does not render the image notably unsharp. It was only during the last week that I thought of making bitumen transparencies by this method of printing against the back of the film, so I have not had time to make many examples.

Mr. Barker has now finished the washing away of the soluble bitumen from those which he took in hand some minutes ago, and, as I exhibit them on the screen, you will see how perfectly all the gradations of half tone are represented. You quite understand that a picture of this kind is solid, the gradations of light and shade being due to a greater or less thickness of bitumen, and that the essential points in producing them are to varnish a thin, transparent medium with bitumen, to expose to light through this medium, and then to dissolve away that portion of the bitumen which has not been acted on by light. The ordinary black varnish sold for backing glass positives will answer very well, and so will some samples of Brunswick black. Here is a transparency which was made with ordinary Brunswick black. Remember, however, that some samples of Brunswick black are not sensitive to light, these being probably made with coal pitch.

I think that by the method which I have just indicated very fine lantern slides may be produced, as there is an entire absence of texture or granularity, and it is probable that the bitumen pictures may be stained or toned without difficulty. As I told you before, I only recently thought of this method, and perhaps some of you will experiment with it.

On the table are some plates and specimens illustrating the process of engraving on bitumenized plates, and you will specially notice the great clearness and sharpness of the lines produced by this method. Messrs. Leitch & Co. have kindly lent me some of their photo-engraved plates, which you will examine with much interest. These copper plates have been covered with a thin film of iron by the electrolytic method, and, as the film of iron is extremely thin, it does not in any way interfere with the printing qualities of the plates.

When the surface of a plate begins to wear a little, and the impressions show signs of deterioration, the plate is sent back to Messrs. Leitch & Co.'s factory, where the film of iron is dissolved off by means of dilute sulphuric acid, leaving the copper plate as good as ever. The film of iron, although so thin as not to injure the printing qualities of the plate, is nevertheless sufficiently thick to protect the copper from injury in printing. The plate having been freed from the first worn-out film of iron, is once more coated with a layer of iron, and is again ready for use. When the second film of iron is nearly worn away, and the printer approaches near to the true surface of the copper plate, the iron is again dissolved away, and a new coating of iron is put. According to this system, one really prints rather from a cast of the plate than from the original plate, and new casts are made as required.

Here are some admirable specimens of photographic engraving by Mr. Dallas, a gentleman who is always to the fore in matters connected with photo-mechanical printing.*

Before you go I wish to call your attention to a very simple and expeditious way of making engraved plates from line subjects. Here is a photo-lithographic transfer made from a positive, instead of from a negative, as is usually the case. You see that the ground is black, and the lines are white; in fact, by far the greater part of its surface is black. I now lay it on a zinc plate, and pass it through the press. Now what will be the result? I will tell you beforehand. So much of the paper being covered with printing ink, and so little being white, moist, and gelatinous, the transfer will slide over the zinc plate, and we shall merely get a smear. Here it is. I have here another transfer similar to the last, excepting that white patches are introduced on it wherever they can be introduced without falling foul of the picture. This is done by painting on the transparency with Brunswick black. On putting this transfer down on a zinc plate you see that it adheres properly, and we have a perfect image on the metal. As the white patches are now done with, I varnish them over, and you see that the zinc is covered everywhere except where the lines of the engraving are bare. The covering on the zinc is now made denser by inking and dusting with resin, as I explained in the last lecture, and the plate is then etched by dilute nitric acid. Here is a plate all ready inked and dusted; I place it in this dish of nitric acid, and allow it to remain a few minutes. I now clean off the ink, and you see the lines are engraved on the zinc plate. The plate may now be printed from in the copper-plate press, or, as zinc is not a convenient metal for deep plate printing, it may be reproduced by the electrotype process.

Printing of Half-tone Subjects from Metal. Application of Asser's Process. Talbot's Photo-engraving. Woodbury's Methods of Engraving and Printing.—When treating of photozincography I gave details of Asser's process, and I showed you a zinc plate bearing the fatty image. Since then I have etched that zinc plate, so as to convert it into a high printing block, suitable for the typographic press. Here it is; here is an electrotypic cast of it; and yonder is a proof from it, hanging side by side with a proof from the unetched plate. In comparing these proofs you will see that a little of the detail has been lost during the etching; but this is not due to any defect in the process, but to the fact that I etched the plate too rapidly. In etching a plate of this kind the reinkings must be done with great caution, and the acid used for the early etchings must be very dilute—say, one part of acid to one hundred of water.

I hope to see Asser's process come into use for large and comparatively rough work, it being well adapted for this. Mr. Dallas has brought the manufacture of typographic blocks, for the representation of half tone, to great perfection, and he has kindly lent me some of these, and also prints from them. Although we do not know what method Mr. Dallas employs in making his "tint" blocks, we can all appreciate the excellence of the results.

The illustrious Talbot discovered a method of printing in half tone by means of etched copper or steel plates, and very beautiful results have been obtained by his method, which I now intend to illustrate to you.

Here is a copper plate which has been carefully cleaned and charcoaled. I slightly warm this and fix it on the turntable. I next pour on it a warm solution containing six parts of gelatine, one hundred of water, and one of ammonium bichromate. The table being now rotated, all excess of the gelatine solution is thrown off, and a thin even film is left on the copper plate. The plate must next be dried at a gentle heat, after which it is ready for exposure to light under a transparency. Here is a plate which has been so exposed, and you will notice that, where the light has acted, the coating has become brown, and at the same time it has become insoluble in aqueous liquids, the degree of insolubility depending on the extent to which the light has acted. The next problem is to etch through the soluble parts of this film without destroying its continuity. This cannot be done by nitric acid, as the acid destroys the gelatine film at once, but a strong solution of iron perchloride will answer the purpose. The plate being now put into this solution of perchloride of iron, the etching has commenced. Those parts of the gelatine film which have not been acted on at all by the light remain very soluble, and allow the etching to take place rapidly, while those parts where much light has acted resist the solution altogether, and those parts which have been acted on by a small proportion of light allow a proportionate amount of the iron perchloride to penetrate. Thus all degrees of light and shade are represented by corresponding amounts of etching. The plate is now sufficiently etched. I take it out, clean off the gelatine; and now it is ready for the press. Here is a proof from a similar plate.

The next process to which I direct your attention is one discovered, perfected, and carried out on a large scale by Mr. Woodbury. The Woodburytype process consists in casting colored gelatine pictures in a metal mould. Here is a metal mould—the method of making it I will describe directly—in which the image is hollowed out, the depth of

* After the lecture, Mr. Dallas informed me that he had been in the habit of coating the surface of his plates with iron, as described above.—T. B.

the hollow being greatest in those parts corresponding with the dark parts of the picture, and everywhere deep in proportion to the intensity of the shade. I place this mould in a dish containing blackened water, so that the water just runs over its face. You now see no picture or anything approaching to a picture. Now notice the effect of pressing a piece of plate glass down on the surface of the mould. The excess of the blackened water is forced out, and the hollows of the mould alone are filled up with the blackened water. Now, as these hollows vary in depth, varying degrees of shade are produced, and a perfect picture is produced. I take the glass off, and the picture disappears; put it on once more, and it reappears. Instead of colored water, I pour on this mould a little colored gelatine and press a piece of plate glass down on the surface. The excess is forced out and the mould filled with colored gelatine. In a few seconds the gelatine will have set, and I shall be able to lift off the glass, which will carry with it the gelatine image. Here it is; it forms a transparency suitable for the magnetic lantern. If, after having flooded the mould with colored gelatine, a piece of paper is laid on, and the excess of gelatine is forced out with a plate of glass, a picture composed of colored gelatine is moulded on the paper, and can be removed as soon as the mould is set. When removed it is dipped into a solution of alum, in order to render the gelatine image insoluble in water.

So much for the general principles of Woodburytype; and now let me show you how you can work this process yourselves.

The first thing is to dissolve about six parts of easily soluble gelatine and two parts of lump sugar in fifteen parts of warm water. Here is the warm mixture already strained through muslin, and here is a waxed glass plate, set level, and bordered with a little ledge of wood. The warm gelatine solution being poured on, spreads itself over the plate, forming an even layer, which, in the course of some hours, will dry, forming a uniform sheet. Well, here is a dry sheet of the gelatine on another piece of glass, and you see that the introduction of a penknife under one corner of the gelatinous sheet brings it off the glass at once. The next thing is to make this gelatine sensitive to light, and for this purpose it is soaked in a solution of potassium bichromate, containing 3½ per cent. of the salt. You see that it has now become quite flaccid by absorbing the solution, and I now lay it on a sheet of glass and remove the excess of solution by means of the squeegee. The bichromated gelatine adheres to the glass, but when dry it will be easily removable.

Here is a glass plate, with a dry sensitive film on it. I take the film off and place it under a negative. It is now ready for exposure to light, and would require about two hours of such light as we had to-day at noon. Here is a printing frame containing three such films, which have had the necessary exposure under their negatives. I put these films in water and let them get moderately soft, but not so soft as the film became during the sensitizing. One of these I take out and lay face downward on a piece of finely-ground glass, another is similarly placed on a piece of glass covered with gold-beater's skin, and the remaining one is put down on a sheet of collodionized glass. The squeegee is now applied to each, and adhesion takes place. In order to enable the gelatine films to firmly fix themselves to the supports, they should remain at rest during a period of about half an hour; but as we cannot wait that time, I have provided a duplicate set previously prepared. Mr. Barker will now put these into warm water, and the gelatine soon begins to dissolve. Now, remember that certain parts of the bichromated gelatine have been made insoluble by the action of light shining through the negative, and these insoluble parts will remain undissolved on the supports (ground glass, gold-beater's skin, and collodionized glass). It will take some little time for Mr. Barker to wash away all the soluble gelatine, but toward the end of the lecture you will see his results in the shape of gelatinous reliefs; thick where corresponding to the blacks of the picture, very thin in those parts representing the whites, and finely graduating between these extremes. When the reliefs have been sufficiently developed they must be dried, and here is a finished and dry set. You see that, having only one hour, it is necessary to get continually in advance of the work, and to take fresh materials which have been previously worked up to a certain stage. Let me begin with the relief on finely-ground glass. This being gently warmed, I put a border of wood round it, and pour on some fusible metal, made by melting together one part of cadmium, two parts of tin, four parts of lead, and seven parts of bismuth. Well, now, if I left this to cool in the ordinary way, the top would solidify first, and the lower layers of metal in contracting would leave small vacant spaces next to the surface of the gelatine, thus rendering the cast imperfect. To obviate this, I place the glass on this cold block of metal and cover the top of the fluid fusible alloy with warm sand. The rest explains itself—the portjon of fusible alloy next the face of the mould becomes solid first. Here is a fusible metal mould made in the way I have just illustrated to you; I oil it slightly, pour some colored gelatine solution on it, and force away the excess by means of flat glass; and when the gelatine has set the glass can be removed, carrying with it the moulded transparency.

Here is the relief on gold-beater's skin, and here is the one which was developed on collodion. These can easily be stripped from their glass supports, as I now show you—one corner being liberated, off they come; I will pass them round for you to look at. Now, in the actual commercial practice of Woodburytype printing, a film relief, such as you are now passing round, is forced into a plate of lead by means of the hydraulic press, and the leaden mould thus obtained is used for printing. I now lay a film relief on the smooth steel base of this screw press, place a piece of lead on the top, and apply pressure. You see the result—the lead has become an exact counterpart of the gelatine relief, which, you will notice, is in no way damaged.

Here is a leaden mould, together with the corresponding relief, kindly supplied by Messrs. Braun & Co., of Dornach, and here is a very fine mould made by Mr. Woodbury himself. I will make a cast in this, and you see that the result is one of Mr. Woodbury's magnificent lantern slides, which are now so popular. It is now projected on the screen, and you can all see it. I take it out, or the heat would melt the wet gelatine, and I pass it round for you to examine, but remember that it is not yet dry, so do not touch the face of it.

I think I explained to you that, in order to get a Woodburytype picture on paper, it is merely necessary to interpose paper between the gelatine, as poured on the mould, and the plate-glass cover, which forces out the excess. To illustrate the matter, I will print one from this mould. Now notice the paper I use. It is thin, hard paper, surfaced with shellac, to prevent the gelatine from penetrating it, and heavily rolled, to make it even in thickness. There is much more which I should like to tell you about the Woodburytype process, but I have not time. You will not fail to notice the admirable collection of prints and illustrative specimens kindly lent me by the Woodburytype Company, Messrs. Goupil & Co., Braun & Co., Bruckmann, and others, who are working the process on a large scale, not forgetting these very fine specimens lent by Mr. Woodbury himself.

I may mention that, in actual practice, one Woodburytype printer can attend to several moulds, and by the time he has filled the last of the series the first is ready to give up its picture. The moulds are arranged on a circular table, which revolves in front of the operator.

Mr. Woodbury has modified his process so as to obtain copper plates suitable for deep printing in the ordinary copper-plate press, and this modification has been worked with the greatest success by Messrs. Goupil & Co., of Paris, who have kindly lent me these magnificent specimens of their work.

A gritty powder is added to the gelatinous mixture employed for making the relief; and, when the relief is made, it is found to be more or less rough, from the projection of the gritty particles. The relief is then rolled against a sheet of lead, so as to make a perfect reverse in this metal. As far as form is concerned, this plate of lead is perfectly adapted for printing in the copper-plate press, the hollows left by the projecting particles of grit holding the ink to perfection. But as lead is much too soft to be used as a deep-printing plate, the leaden plate is reproduced in copper by the electrotype process, two electrotypings being, of course, necessary, one to make a reverse mould and a second to make a cast of this mould, or a duplicate of the original leaden plate.

BLOWPIPE CHEMISTRY.

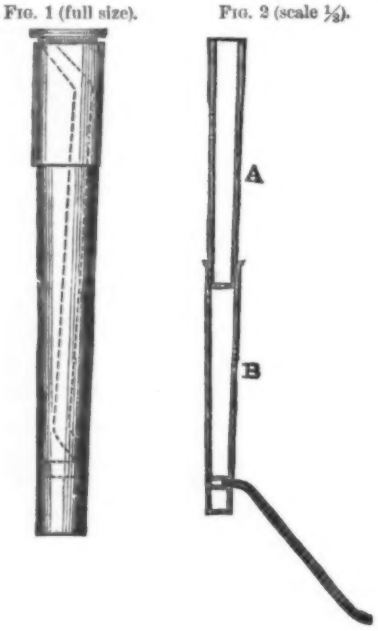
By P. CASAMAJOR.

I. THE SHORTEST POCKET BLOWPIPE.

OVER two years ago I published in the *Chemical News* (vol. xxxiii., p. 50), and in the *American Chemist* (December, 1875), a description of a blowpipe, which, when packed for the pocket, has a length of 4½ inches, and, when adjusted for use, gives a length of 8 inches from the mouth-piece to the tip of the jet. This relation of 4½ to 8 was a trifle less than that of any pocket blowpipe that had previously been proposed.

In the above description, as published in the *Chemical News*, occurs the following: "If the stem of the blowpipe is made

FIG. 1 (full size). FIG. 2 (scale ½).



in two pieces, while the jet is made with a double curve, the length, when put up for the pocket, can be reduced to 3¼ inches, which gives the still smaller ratio of 3¼ to 8, which, I believe, has never before been attained. I have one of these dimensions whose stem is formed of two conical portions with circular sections. When packed for carrying, one cone fits into the other, and the curved jet fits within the inner cone."

As neither at the time of publishing the above, nor since then, has the figure or a detailed description of this blowpipe been given, I propose to give both now, as I believe that this blowpipe still enjoys the distinction of being, when packed for the pocket, the shortest ever made. In Fig. 1 it may be seen in this condition, and in Fig. 2 it is shown as arranged for use.

In this figure we may see that the stem is formed of two conical tubes, A and B, of about the same length. The small end of A enters into the large end of B. The larger end of A is left open, while its smaller end is closed with a plate having a hole in its center, to allow the passage of the air into B. The conical tube B is also open at its larger end, but closed by a plate at its smaller end. About half an inch from the smaller end is an opening in the tube B, made to receive a small piece of pipe, which is soldered to edges of the opening, and to a place inside of the tube, B, diametrically opposite to the opening. This short piece of pipe, which serves as a socket to receive the jet, is provided with a hole to allow the air to escape from the tube B into the jet.

A blowpipe of this kind is very easily made by taking two ordinary jeweler's blowpipes, which cost about 15 cents apiece, and filing off the curved portion. There remain two straight conical tubes, which are placed one within the other. We may then cut from the outside tube a piece about 3 inches long, from which we make the tube A. At the smaller end is soldered a perforated plate. From the inside tube we make the pipe B by closing its smaller end with a plate and by putting a ring around its larger end. This ring answers the purpose of stiffening this end and keeping its shape true, and it also serves to take hold of when the tube B is to be drawn out of the tube A (Fig. 1). The perforated plate at the smaller end of A is also designed to keep this end from deformation. It also serves as a diaphragm with a small perforation to divide A from B, which allows the stem to be divided so as to leave a lower chamber, which some think is an advantage in the case of the blowpipe of Gahn, commonly ascribed to Berzelius or Plattner.

It may be noticed in the figures that the larger end of A is made thicker than the rest of this tube. This extra thickness represents a silver tube soldered over the brass tube in the part that enters in the mouth.

The jet is made from a piece of brass tubing. Before curving it, it should be filled with rosin, to prevent it from collapsing. This jet should be made to fit very accurately in a larger piece of tubing, which is afterward soldered in the tube B, to serve as a socket for the jet, as shown in Fig. 2. To prevent the jet from dropping out of the inner tube, this is closed with a cap, the edge of which is shown in Fig. 1.

II. CHARCOAL BORERS.

In his excellent work "On the Use of the Blowpipe in Chemical Analysis and Mineralogical Determinations," Berzelius gives a charcoal borer, which is remarkable for its

FIG. 3.

extreme simplicity. It consists in a conical tube of tin plate, open at both ends, these ends being sharpened with a file, so as to present two circular edges. By using either the larger or smaller end of the cone we may bore holes of two different sizes in charcoal. The diameter of the larger end is about half an inch, and that of the smaller about a quarter of an inch.

This borer is not generally known, those of Plattner being the only instruments of the kind in general use. These have the advantage of making a hole more quickly, and they never leave a core, which, in the case of the tubular borer, has to be removed afterward with some care. Plattner's large borer gives a cavity with a rounded bottom like that of a crucible, which is often an advantage. These borers of Plattner are somewhat expensive, and also quite difficult to make, so that if a chemist was in a locality where they could not be bought he would not find it an easy matter to make them for himself.

I have been using for several years a form of charcoal borer which works with great rapidity and perfection, and which is of the easiest construction. The holes made by this borer are cylindrical, or slightly conical, with flat bottoms. Quite lately I have devised another form which gives cavities with curved bottoms like Plattner's larger borer, and which is also of the simplest construction, so that any one may, with little trouble, make one for himself.

The first of these forms is the conical tin tube of Berzelius, with two modifications, one of which consists in making each base of the tube not a complete circle, but about three-quarters of a circle, as represented in Fig. 3, the object of which is to facilitate the removal of the core, as will be explained. The other is that the edges of each end are not like the edge of a knife, as in the tube of Berzelius, but like the edge of a saw.

Fig. 4 represents a side view of this borer. At each end of the tin tube it may be seen that a portion, about a quarter of the metal, has been cut away. The middle portion of the tube is left entire, and the edges at this portion should be brazed or soldered together to insure stiffness. Fig. 5 shows the shape of the sheet metal from which the borer is made. The edges, *a* and *b*, are to meet or overlap, and are to be brazed or soldered together.

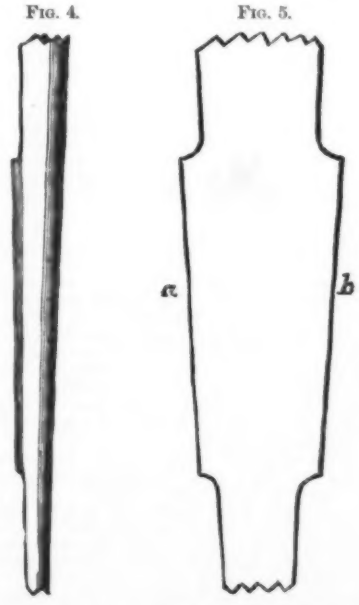
This borer gives well-shaped holes with remarkable quickness. When the hole has been made deep enough the core is easily detached by pressing the tube against it, so that the core is pushed into the free portion of the groove, which corresponds to the part which has been removed from the conical tube.

If a borer of this kind is made with a large diameter, so as to leave a thick core which is not easily detached, a smaller hole may be bored in the core with a smaller instrument, after which the core is easily broken up and removed.

By alternately bending the teeth at the bases of the cone outwardly and inwardly, as in the operation called *setting* for carpenters' saws, a wider groove is left around the core, which is more easily detached when the borer is of large size.

The charcoal borer which gives cavities with curved bot-

FIG. 4. FIG. 5.



toms is made by cutting a plate of metal so as to give it the shape shown in Fig. 6, and bending over perpendicularly to the surface of the plate the portions at each end which project beyond the dotted line. These projections are bent in opposite directions, as shown in Fig. 7. The dotted lines which show the outline of the borer form an ogive, which gives a good-shaped cavity. The portion beyond the dotted line

which is bent perpendicularly to the face of the plate, as we have already said, should have its edges sharpened with a file to enable the borer to work more rapidly.

By pressing this borer against a piece of charcoal, and turning it alternately to the right and to the left, a good cavity is obtained in a very short time. Borers of this kind should be made of pretty stout metal, as otherwise they become twisted by use. Tin plate known in the trade as *three cross* is sufficiently thick for the purpose.

III. SHEET-IRON SUPPORTS.

I have been using for some time pieces of sheet iron for supporting substances before the blowpipe flame. Sheet iron presents several advantages for this purpose, in being very common everywhere, in costing little or nothing, and in being durable, so that the same piece may be used over and over again many times. We cannot on a plate of this kind exhibit the action of fluxes which attack iron, but we may see with distinctness the rings or deposits that are given before the blowpipe flame by antimony zinc, bismuth, etc.

We may also obtain copper, lead, silver, tin, bismuth, etc., in the metallic state by the reducing flame, particularly in presence of carbonate of soda or cream of tartar.

To use sheet iron as a support it must, in the first place, be rubbed with a piece of pumice or of Bath brick and water, until the plate looks bright. Thereby all dirt left by a previous operation and all rust are removed. Before placing anything for testing on the plate it is advisable to blow the blowpipe flame on it for a few seconds, when it becomes covered with a shining dark gray coat of magnetic oxide, on which the rings or deposits are seen with distinctness. We may, if we think preferable, cover the plate with a coat of soot by holding it in the flame of a lamp or candle. On this coat the deposits take place equally well.

I generally use the thinnest sheet iron obtainable, which is the kind on which are taken the photographs called *ferrotypes*. Sheets of this thickness are easily bent into any convenient shape. They may be used over and over again without any perceptible diminution of their thickness.

Iron has the advantage of being relatively a poor conductor of heat, which property enables us to hold in the hand one end of a piece of sheet iron not more than 4 inches long, while the other end is in the blowpipe flame. If a handle is found necessary, the piece of sheet iron may be held in a cork provided with a cut in which to insert it.

If we should want to use charcoal, I may point out that we can use a metallic plate as a charcoal holder, by making two slits crossing each other at right angles, and bending the four tongues obtained in this way, about perpendicularly

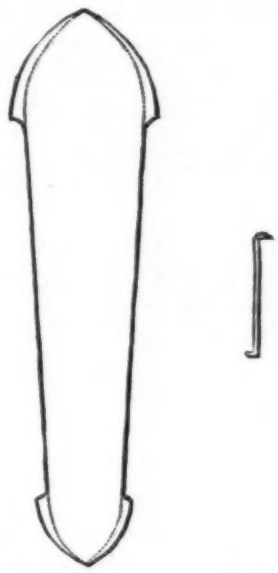


FIG. 6.

FIG. 7.

to the surface of the plate. In a hole thus made in a plate it is an easy matter to hold tightly a small piece of charcoal by bending the four tongues more or less. The ring formed by the action of the flame may extend beyond the charcoal on the metal plate. This is in imitation of the plan proposed by Prof. Le Neve Foster of using a plate of unglazed porcelain provided with a cavity for holding a piece of charcoal.

We may, instead of this, make a cavity in a piece of sheet iron by indentation, and fill it with a paste made by mixing the substance to be tested with an excess of charcoal powder or black flux and a little water. After heating the mass we may obtain the metallic particles by triturating in a mortar with water and washing away the residuary carbon. If deposits are formed they will be found on the sheet iron around the cavity.

IV. ALLOYS OF LEAD AND TIN.

The reactions presented by alloys of lead and tin before the blowpipe flame are of such interesting nature that I need no apology for bringing them to your attention. I am not aware that the behavior of these alloys has been specially noticed, with the exception of a brief note in an excellent paper, by Prof. Chapman, of the University of Toronto, "On Some Blowpipe Reactions," in *Chemical News* (vol. xxxv., p. 13). In the ninth section of this paper, relating to alloys, occurs the following: "*Lead and tin* unite readily, but the globule commences immediately to oxidize, throwing out excrescences of white and yellow oxide. On removal from the flame it still continues in ignition, and pushes out further excrescences. The unoxidized portion, if any, is malleable."

The reactions presented by alloys of these two metals had already attracted my attention when this note was published, as I wrote at the time to Prof. Chapman, in the course of a lively but very friendly correspondence on the occasion of his strictures on Turner's test for boracic acid.

The fohowing experiments illustrate the points of interest in alloys of lead and tin: they were all tried with 6 decigrms. of alloy made from pure lead and pure tin:

Experiment 1.—Melted together 3 decigrms. of lead and 3 decigrms. of tin. By continuing the heat before the blowpipe the alloy gives small bunches of excrescences, resembling cauliflowers. After awhile the excrescences increase progressively as the blowing continues. They are at first white, afterward yellowish. Finally the whole mass resolves itself into cauliflowers of deep orange color. During the formation of these excrescences copious white and yellow fumes are given out and deposited on the charcoal.

Experiment 2.—The 6 decigrms. of alloy are formed of 4 of lead and 2 of tin. In this case the reaction is violent from the very first. The bunches of cauliflowers, of a deep yellow color, are formed as soon as the metals are heated. On ceasing to blow, the reaction goes on in a lively manner. Thick fumes are given out and deposited on the charcoal.

Experiment 3.—The 6 decigrms. are formed by taking 4 of tin and 2 of lead. In this case the cauliflowers only begin to form in small bunches of white color after persistent blowing. Fumes are given out slowly, and a malleable button is left.

Experiment 4.—Lead, 5 decigrms.; tin, 1 decigrm. After blowing a short time the deep yellow cauliflowers form, until the whole mass is oxidized. The reaction is apparently less violent than in Experiment 3.

These experiments show that when the lead is double of the tin the reaction takes place with more energy than with any other proportions. This is worthy of attention, because the atomic weight of lead (207) is nearly double of the atomic weight of tin (118). It makes it probable the deep yellow cauliflower-like excrescences are a stannate of lead. These reactions, with an alloy in which the weight of the lead is double that of the tin, also show that this alloy, when heated, absorbs oxygen with exceeding avidity, which fact may find future applications.

Although an alloy of these proportions absorbs oxygen with great avidity, Experiment 4 shows that an excess of lead does not seem to interfere in a marked degree with the reaction.

Experiments 1 and 3 were made with excess of tin, which, contrary to what takes place with lead, interferes with the formation of the excrescences.

In Experiment 3 the tin was in large excess, and the reaction was very indistinct.

A point of interest in connection with these reactions is that although tin does not give any fumes, and that those given out by lead are very slight, alloys of these two metals give fumes which are excessively abundant, and which might mislead a person who is not on his guard to believe that zinc or antimony is present.

As both lead and tin are ordinary blowpipe reagents, it may be as well to suggest that when either of these bodies is suspected in a metallic substance to be tested, the addition of the other may furnish useful evidence. As the specific gravity of lead is 11·4 and that of tin 7·5, we may, without weighing, get approximately at the quantity of either of these metals to be added by estimating the volume.

As an application of the foregoing I may mention that the bright foil called tin foil—which is so extensively used in this country for wrapping around substances to be used for food—must, from its behavior before the blowpipe, contain about twice as much lead as tin. I have not determined these proportions quantitatively.

In some works on the blowpipe it is mentioned that when a button of tin is strongly heated before the blowpipe it continues to burn after the flame is withdrawn. I have never been able to obtain this reaction with pure tin, but it takes place readily when lead is present with the tin in sufficient quantity. The tendency to oxidation is so great in a button of alloy in which the weight of lead is double that of tin, that I do not believe that even the most expert operator would be able to keep a button of this kind from oxidation in the most perfect reduction flame that could be obtained.

V. REACTIONS FOR IODIDES, BROMIDES, AND CHLORIDES.

Several years ago Von Kobel observed that when sulphide of bismuth is heated on charcoal with iodide of potassium, a bright red coat of iodide of bismuth is obtained. From this he proposed a mixture of equal parts of sulphur and of iodide of potassium for the detection of bismuth, which he succeeded in finding in a mineral, accompanying joseite, in which it had never been suspected. Prof. Cornwall shortly after proposed the same reaction for the detection of bismuth in the presence of lead and antimony.

The ready formation of iodide of lead, by heating a plumbic compound with the mixture of sulphur and iodide of potassium, induced me to try the detection of iodine by heating an iodide with powdered galena. The characteristic yellow coat of plumbic iodide is deposited as soon as the flame touches the mixture. By heating chloride of sodium with galena an abundant white coat of oxychloride (?) of lead is deposited. With bromide of potassium and galena a white deposit of plumbic oxybromide (?) is obtained. When iodides, bromides, and chlorides occur together, it is not possible to separate them by the use of galena, as a yellowish white coat is deposited when an iodide is mixed with either a bromide or a chloride, from which I have found it impossible to separate the yellow from the white.

If, however, instead of galena, we use a mixture of sulphur and bismuth, in connection with a mixture of an iodide with a chloride, we will obtain a yellowish coat, and beyond this red streaks. At first this result is not very promising, as the yellowish deposit resembles a mixture of iodide of lead with chloride of lead. But if we let the plate cool, and afterward heat the yellowish deposit very slowly and carefully, the yellowish coat will separate into an outer ring of bright red iodide of bismuth and an inner ring of oxychloride (?) of bismuth, which, on cooling, becomes perfectly white.

If we try the same experiment with a mixture of bromide and iodide the result is not quite so satisfactory, for although the yellowish coat—resembling that of the preceding case—becomes white on heating, the heat necessary for this causes the iodide of bismuth to be driven beyond the plate, and, although the red fumes are distinctly seen to escape, the red iodide does not remain as a witness on the plate. We may, however, by using an open tube, and by placing the mixture to be tested at one end of this tube, drive the mixed fumes of oxybromide (?) and iodide of bismuth up the tube. If afterward we heat slowly and carefully the deposit near the end of the tube to which heat was previously applied, the white oxybromide (?) will remain, and the bright red fumes of the iodide will be driven further up the tube and deposited on its sides.

By means of a mixture of sulphur and bismuth we may, then, separate iodine from bromine and chlorine, but the separation of bromine and chlorine from one another is not possible with sulphide of bismuth.—*Chemical News.*

OPTICAL DEFECTS AND SPECTACLES.

By DUDLEY S. REYNOLDS, M. D., Louisville, Ky.

AN optical defect is a condition wherein the optical properties or refracting power of the eye is such that rays of light passing through the pupil are not focused in the bacillar layer of the retina.

The general divisions, hypermetropia and myopia, refer to conditions directly opposite each other; one being due to insufficient converging power in the crystalline lens, the other being due to an abnormal increase of the distance between the lens and retina.

In hypermetropia of high grade light is not focused at all; while in every form of myopia the light is focused before it reaches the retina; so that in both conditions the visual power is defective, for want of proper adjustment of the refracting media. Hypermetropia may be simple, uniform, irregular in the different meridians, or compounded with myopia; as, for instance, in the eyes of some a certain meridian is found to be hypermetropic, while the opposite meridian is myopic. Analogous complications are frequently found in myopic eyes.

The changes which are brought about by age limit the focusing power, or accommodation, thus diminishing the refraction, and giving rise to a condition practically identical with hypermetropia. Hypermetropia less than one-twelfth is likely to be overcome by straining the accommodation power until the subject attains adolescence, except in those cases wherein the defective refraction is greater in one eye than in the other; squint arises from the unequal adjustment, the great strain upon the accommodation in the one eye used produces muscular asthenopia, or spasm of accommodation, and the patient is forced to seek relief. When the hypermetropia is concealed by the excessive power of accommodation, Mr. Laurence thinks spasm of accommodation exists. This is far from the truth. Spasm of accommodation of the eye is one of those excruciatingly painful states often described as ciliary neuralgia, and cannot be relieved without removing the necessity for that strain which the defective refraction entails.

The almost universal practice of correcting only a part of the defect at a time, gradually increasing the power of the lenses until the error of refraction has been overcome, is not founded in reason, nor is it justified by any man's clinical experience. Donders says, and all the world bow in humble submission to his dictum, that where the error of refraction is different in the two eyes, glasses of equal focus should be ordered, in accordance with the defect in the eye least affected. This is an error; allowing that the accommodation is about equal in both eyes—and it has been observed to differ in the rarest cases only—whatever defect of refraction may be found should be carefully and entirely corrected, testing always each eye separately; then the accommodative power has but the normal amount of labor to perform; and, no inharmonious work being required, every source of difficulty in the way of defective vision is removed.

Donders says where astigmatism amounts to less than $\frac{1}{12}$ its correction need not be attempted. This error has been a fruitful source of glaucoma; in many instances it has caused posterior staphyloma.

I have been often consulted by persons suffering with asthenopia, and sometimes with spasm of accommodation, who informed me that they had been to some famous confrère, who had ordered glasses, and while some benefit had been derived, the weariness, or pain, had returned. Careful testing revealed irregular refraction of low degree, often as low as $\frac{1}{20}$; this being corrected, years of literary labor failed to reproduce the trouble, thus proving the necessity for full correction of the entire deficiency of refracting power.

On the 16th of October, 1876, I was consulted by a lad, thirteen years of age, who had been the rounds of the profession, receiving glasses from each specialist consulted, and, being still unable to read without pain, was obliged to quit school. He had been ordered spherical glasses, $+\frac{1}{12}$ to $+\frac{1}{20}$, all of which improved vision; but the pain would return, and, in a few minutes, reading became impossible. Using a four-grain solution of sulphate of atropia twice every day, in two weeks the pain had entirely ceased; the accommodation being full paralyzed, I found astigmatism $= +\frac{1}{12}$ in the right eye, and $+\frac{1}{15}$ in the left. The spherical aberration being $= +\frac{1}{24}$ in the right eye, and $+\frac{1}{30}$ in the left. Compound cylindrical lenses adequate to the correction of these seemingly small deficiencies of refraction gave perfect immunity from pain or fatigue, and the lad has gone on with his studies uninterruptedly since he began to use the glasses.

In correcting defects of refraction it is always important to have the accommodating power wholly suspended. Where this is partially done, or not regarded at all, success is impossible.

That the advance of civilization is attended with an increasing number of near-sighted eyes, and that this is largely due to a lack of early correcting congenital defects of refraction, is no longer to be doubted. The more general diffusion of educational advantages calls for more general use of the eyes for near and accurate vision, and where errors of refraction exist uncorrected, the constant strain of accommodation so augments the tension of the eyes as to produce inflammatory changes in the posterior part of the globe, ending in staphyloma posticum, and its almost necessary accompaniment, myopia.

No mention is made here of that class of defects due to age, because presbyopia depends upon such senile changes in the structure of the lenticular body as tend to reduce the power of accommodation rather than to increase it, consequently no serious effects are likely to result from neglecting to correct it.

The subjects herein briefly treated are of such great importance to the general practitioner, as well as the specialist, that I feel no apology is due from me for introducing a matter so purely scientific. There is too little attention paid to the early correction of optical defects, and too much aversion, in this country, to the use of spectacles. The sooner these prejudices are overcome, the sooner will there be a decrease in the number of blind people. And it is time the medical profession should cease to encourage the itinerant spectacle vender, for no one but a practical ophthalmologist is competent to say when we shall wear glasses, what kind we shall wear, and how we shall wear them.—*Med. and Surg. Reporter.*

TREATMENT OF TYPHOID FEVER.

DR. J. R. GROOVER, of Mica, Pickens County, Ga., writes to the Atlanta *Medical and Surgical Journal*:

I propose briefly to give a plan for treating typhoid fever that has proved very successful in my hands, having used it in a great many cases during the past three years:

Diluted phos. acid, 20 gtts. every four hours through the day, alternated with a powder composed of ipecac, camphor

and prepared chalk, powder being changed as indications may require. To allay nervous irritation and procure rest, bromide potassium every three hours through the night.

If the patient has more than three operations of the bowels in twenty-four hours, I usually prescribe tannic acid and opium, to be taken every time the bowels operate, until the diarrhœa is checked or the patient is thoroughly under the influence of the opium.

These remedies, with sponging the body and cold cloths to the head when the fever is high, and corn whisky through the night, if it is of the lower grade, with the necessary nourishment four times a day and once at night, will cure nearly every case of uncomplicated typhoid fever.

CONTAGIOUS DISEASES AND THEIR PREVENTION.

By A. J. JESSUP, M. D., Westtown, Orange County, N. Y.

RECENT advances in biological science lead to speculations concerning the influence of minute living germs on the production of putrefaction, suppuration and septicæmia after operations, wounds and other solutions of continuity. The germ theory is destined, in my opinion, to work a revolution in former ideas of the origin of diseases of contagious and putrefactive character. This communication is intended as an humble contribution to the subject. It is possible that the ideas herein contained may have been elaborated; if so, they have escaped my notice. I simply will endeavor to suggest a means for preventing the spread of contagion, also a means of preventing putrefactive and inflammatory changes after operations, especially those operations which involve the opening of large cavities, and the more extensive of what are called capital operations. I will now illustrate the principle by quoting from Tyndall: "In a germ-infested air (I will say the purest contains them in larger or smaller numbers) chop up a beefsteak, let it remain two or three hours covered with warm water; you thus extract the essence of the beef in a concentrated form; by properly boiling and filtering you obtain a perfectly transparent liquid. Have a box prepared, which is free from germs, all motes being excluded by filtering all the air that enters the box from without. Into the bottom of this chamber fit three or four test-tubes, perfectly clean, filled with the liquid, the tubes so arranged as to project externally from the bottom of the box. On opposite sides of this box fit glass windows accurately so as to be air-tight. The means used to render the air in the box and all that enters from without perfectly moteless—first varnish the interior with glycerine two days before the beginning of the experiment; fit into opposite sides of the box an open tube, stoppered with cotton, wetted with glycerine, for entrance and egress of water. By allowing the whole to remain quiet for a time the motes settle, and, of course, adhere to the sides and bottom of the box.

"By boiling the liquid contained in the test-tubes you destroy all germs which may have found entrance. If the experiment has been carefully performed, the beef-tea will remain clear and sweet indefinitely. Take some of the same solution and expose it in test-tubes to the open air of the same room after boiling, and after a number of days it will fall into rottenness, become turbid, and, under the microscope, will be found swarming with bacteria and living moving germs, whereas the former specimen from the box will be found clear, and destitute of germs or signs of life. To further clinch the experiment, expose some of the latter to the air of the same locality for a time, when it, too, will become putrid, swarming with bacterial life.

"There is no difference between the air within and the air without the chamber, except that the former is moteless, and the latter laden with the dust which contains the germs of putrefaction ready to spring into life under favorable conditions.

"In the light of such experiments it is simply monstrous to assume—as some have done—that these bacteria are spontaneously generated.

"We now approach an aspect of the question which concerns us more closely, which will be best illustrated by an actual fact. A few years ago I was bathing in an Alpine stream; on returning to my clothes from the cascade, I slipped upon a block of granite, the sharp crystals of which stamped themselves into my naked skin. The wound was an awkward one, but being in good health at the time, I hoped for a speedy recovery. Dipping a clean handkerchief into the stream, I wrapped it closely round the wound and limped back home, remaining four or five days quiet in bed. There was no pain, and at the end of this time thought myself able to leave the room. The wound when uncovered was found perfectly clean, uninflamed, and free from pus. Placing over it a piece of gold beater's skin, I walked about all day. Toward evening, itching and heat were felt; a large accumulation of pus followed; I was obliged to take to bed again. The water bandage was restored, but it was powerless to check the action now set up.

"I was taken to Geneva, where my surgeon discovered an abscess in my instep five inches from the wound, communicating by a sinus, through which the abscess was evacuated without a resort to the knife.

"By what agency was that channel formed in the sound tissue of my instep, and kept me a prisoner for six weeks?

"In the very room where the water dressing had been removed and the gold beaters' skin applied, I opened this year (1876) a number of tubes containing perfectly sweet and clear infusions of fish, flesh and vegetables.

"These hermetically sealed infusions had been exposed for weeks to the sun of the Alps and the warmth of a kitchen, without showing the slightest turbidity or sign of life. But in two days after exposure to the air of the room, the greater number swarmed with the bacteria of putrefaction, the germs of which had fallen into the tubes after being opened in the dust-laden air of the room. And had the pus been examined, my memory of its smell and appearance leads me to infer that it would have been found equally swarming with bacterial life."

Mr. Tyndall then refers to the labors and successes of Mr. Lister, and proceeds to trace the analogy between contagion and a ferment, which latter is a cell growth from one single or a few cells to many millions, so with a particle of contagium it spreads throughout the human body, and may be so multiplied as to strike down whole human populations. Consider the effect produced by the introduction of a microscopic quantity of the virus or ferment of small pox, which virus is to all intents and purposes a seed. In Pasteur's experiments a bacterium always remained a bacterium, the vibrio a vibrio, the penicilium a penicilium, and the torula a torula; sow any of these in an appropriate liquid and you get it alone in the subsequent crops. In like manner sow small pox, and you get small pox; scarlet fever, your crop is scarlet fever; typhus or cholera, and the product is these diseases, multiplied in just the proportion in which they have soil for development, and the conditions favorable to continuance of these diseases are exactly those which we need for propagating our putrefactive animalcula.

We are living in an age of the world when old and long established dogmas and beliefs, which have the prestige of hoary ages, are being swept away by the onward march of progress. Authority as such is of no value or of value only as far as it accords with reason, observation and experience. The recent discoveries in biology and physiology are changing our opinions concerning life and its origin.

Some here present may remember when diseases were thought to be the operations of divine judgment. We are gradually learning to trust to reason and observation in forming our opinions, recognizing the grand conception, universal reign of law. Apparent exceptions or contradictions only cover some deeper law.

The microscope and experiments on living bodies of animals are gradually unvailing the processes of nature of development. By inoculating animals with diseases, we have a method of interrogating nature, which questions asked in a proper manner cannot fail to elicit satisfactory replies.

Let us be encouraged to persistence in the study of science, in all those branches bearing upon our art. In opening this subject I can but barely touch upon these important questions. We cannot claim to have opened more than the title page of this great subject of contagion and putrefaction. But in calling your attention, we are opening a field which I am certain will be most prolific of facts to investigators of to-day in natural history of diseases, and to students of the future a field of marvelous promise for the benefit of our race.

In 1850 the French observers, Davaine and Rayer, noticed in the blood of animals dying with a virulent disease called "splenic fever" small transparent rods under the microscope. But neither of them attached any significance to the fact. In 1874 Burdon Sanderson gave a very clear account of what was then known of the above disease. The contagion had been proved to hang for years about a locality where it had once prevailed. This seemed to show that the rod-like organisms could not constitute the contagions, as their infective power was found to vanish in a few weeks.

At this time a young German, Dr. Koch, studied the habits of the rod-like organisms. He found the aqueous humor of an ox's eye peculiarly suitable for their growth; with a drop of this he mixed a minute speck of blood from a diseased animal containing these rod-like bodies, placing it under the microscope, warmed it suitably, and observed its action. At the end of two hours the rods began to lengthen. At the end of four hours they had increased ten or twelve times the length. At the end of six or eight hours they had increased many hundred times the original length. At length he noticed little dots appearing at regular intervals along the rods, these developing until the rods became studded throughout with little ovoid bodies, which lay within an outer integument like peas within a shell. By and by this shell fell to pieces; in place of rods the field was taken by long rows of seeds or spores. Koch proved by this and further experiments that these spores, as distinguished from the rods, constituted the virulently contagious elements of splenic fever. When these were dried they did not lose their contagious properties. These spores would produce the fever in its most deadly form. The name of this formidable parasite is anthraces. To produce its characteristic effect they must be introduced into the blood or lodged upon the surface of the nasal or bronchial mucous membrane.

The virulently infective spleen may be eaten by some animals with impunity. It is also impossible to inoculate dogs, sparrows or partridges. The probable explanation is that in these the seed did not find the pabulum requisite to full development. A knowledge of the nature of this germ was necessary to stamping out the disease, which was accomplished by separation and destroying infected animals and purifying by disinfection the infected localities.

One item of statistics will show its prevalence. In the district of Novgorod, Russia, between 1867 and 1870, 56,000 cattle were destroyed, and 528 human beings perished with the same disease; symptoms were those of the most virulent type, destroying in a few hours.

It is not necessary that the germ should be conveyed in liquid, but becoming dry and floating in the atmosphere, being breathed in the lungs, they are competent to produce the characteristic symptoms.

The analogy is too close to be overlooked in studying the causes of other contagious diseases for us not to be reminded that we have good ground for the opinion that all may be due to the action of germs. Thus we see that as quarantine and disinfection will certainly prevent the spread of contagion from patient to patient, may we not confidently hope, by preventing the entrance of germs into the lungs and blood by a properly constructed filtering mask, to yet witness the spectacle of a population walking about the streets of a cholera infested city without fear of its infection, however deadly?

Inasmuch as a properly made cotton filter worn over the mouth and nose must shut out all atmospheric germs of the ordinary putrefactive kind, we may be confidently assured that those of disease will be equally excluded.

By making a brief reference to my own experiments, I found that those tubes which were stoppered with cotton wool while being boiled remained perfectly sweet and clear, while those remaining open soon swarmed with living bacteria and amœbæ.

I humbly trust that some lover of science and friend of his race will put this idea here advanced to practical account. It does not seem difficult for some practical genius to invent a cotton-wool respirator of sufficient fineness to exclude germs, yet to freely admit air for the uses of respiration. Then, at last, in the progress of years, the great problem concerning the practicability of stamping out contagious diseases would reach a solution. They would become extinct, because the conditions of existence were no longer present. Thus to scientists and physicians would belong the triumph of banishing forever these destructive enemies of mankind.

Having dealt rather fully with the origin of specific contagion, let me proceed to ordinary contagion, nearly everywhere present in the atmosphere, viz., the germs of putrefaction.

We often hear it said that an unsanitary locality is just as liable to escape fevers, etc., as one perfectly salubrious. The explanation is as follows: Specific germs go in clouds, and may strike one here, another miles away, so making centers of contagion. The filthy locality may escape this specific influence, but the putrefactive products and germs they have always with them. When once specific germs arrive, they find a rich soil for their growth and propagation. But when in this connection we remember how badly surgical operations and injuries with solutions of continuity are wont to do in an insalubrious atmosphere, we come to the aspect of our subject which I now propose to consider and conclude. The germs everywhere present in the atmosphere are competent to produce putrefaction. By adopting Mr. Lister's antiseptic method we will accomplish wonders: but it seems to me there is a defect here which could be remedied in a somewhat more rational manner. The idea which I wish to advance is simply this: Suppose instead of creating a germless atmosphere immediately around the wound, we should place patient, surgeon, attendants, nurses, etc., altogether in a room whose atmosphere is optically pure, without a germ. This can be accomplished in the following manner: At first, let me say, should it be objected that this will cause a great deal of trouble, I would answer, Should any of our great ovariotomists be almost sure of making a successful operation in all but a small percentage of cases, would he think any amount of trouble in preparatory precautions excessive?

Nearly all the deaths from ovariotomy result from peritonitis or septicæmia. And did the operator not fear them he would render his operation almost as successful as the ordinary minor operations of surgery—in other words, he would only have to fear shock, hemorrhage and certain accidents of injury to internal organs unavoidable in cases of adhesions, etc.

Now to our

"MODEL WARD."

Given a room, large, well lighted, warmed, when necessary, by fire-places, which, when not in use, should have their flues hermetically sealed. We must, as we proceed, keep in view that a solution of beef, fish or vegetable will remain perfectly sweet, clear, and under the microscope without living germs, when exposed to a filtered moteless air. This is exactly what we propose to do with our ward. All windows used for lighting are kept closed and hermetically sealed.

At one end, and outside of our ward, we have established an engine for pumping air out of this ward. At the opposite end we have certain apertures filled compactly with cotton-wool, say inclosed firmly in a wire frame. As the air is removed by the engine it is replaced by external air, minus the motes. In order to make a more perfect filter of the cotton it may be moistened with glycerine. We will now have renewed the air in the ward. But there may be some germs remaining, so we will varnish the walls, floor, and every article of furniture with glycerine and carbolic acid, very strong. Now leave the room and air within perfectly quiet for three or four days, when all the motes will have settled, the glycerine causing them to adhere and the acid destroying their vitality. Then the air of the room could be changed as often as necessary by the engine for purposes of ventilation.

An ante-room, to be used only by nurses, surgeons, etc., to be rendered moteless in the same way, in which the surgeon should change his ordinary apparel for clothing that had been exposed to an extremely high temperature, and, if necessary, disinfected of all germs by acid. The instruments should be then and there subjected to solutions of acid. By not having one single unnecessary article of clothing, bedding, etc., in the ward, and those there should be subjected to thorough disinfection, they then might proceed to operation, confident that the conditions for excluding germs were far superior to those of Mr. Lister. And I am confident that results will, if the plan is rigidly carried out, be better than his, and, moreover, this antiseptic method is applicable to cases in which the acid spray would cause so much irritation as to increase the risk of the operation without fairly preventing the entrance of germs from the surrounding air.

There are many details of course unnoticed in this article which suggest themselves to the operator, such as a thorough bathing of the patient, cleansing the nails, etc., which are not necessary to embody in this article, which may be looked upon as a proposition requiring the united action of some hospital organization, and not to be carried out by a single individual, unless endowed with more wealth than the generality of physicians.

The progress of hygienic science requires us to weigh well and make use of every means that will conduce to the improvement of health or prolongation of life. By laying much stress on germs and contagions, I do not forget other factors which must enter into our estimate when considering causes of diseases and death.

The purpose of this article was merely as a hint which would be enlarged on, and, I hope, to be brought into practical shape by those far better qualified than myself.—*Hospital Gazette.*

THERAPEUTIC VALUE OF NITRATE OF LEAD.

THE late Dr. Madison Marsh, of Louisiana, a few years ago urged upon the profession, through the columns of this journal, the very great value of nitrate of lead in many skin affections and superficial erosions. Some recent observations of an Italian physician, Dr. Galletti, add further evidence on this point. This writer states that he has recently effected a cure in three cases of epithelioma, in one of which the part affected was the nose, in a second the cheek, and in the third the sternum. The mode in which he applied the remedy was by dusting the powder over the affected part, and recovery took place when this had been done about four times. Two obstinate ulcers of the foot, which had proved rebellious to other methods, quickly recovered under the same treatment. Dr. Vanzetti has recently recommended the use of the nitrate of lead in onychia maligna.—*Medical and Surgical Reporter.*

CARBOLIC ACID.

MESSRS. F. C. CALVERT & Co., of the Tower Chemical Works, Bradford, write, in answer to Professor Wanklyn's condemnation of the general use of carbolic acid as a disinfectant, on the ground of its being a poisonous product, that "if such an argument were allowed as valid against anything introduced for the public welfare and convenience, it might equally well be applied to railways, on which a large number of persons are yearly killed and maimed." They further say: "We claim that 'genuine' carbolic acid is the most effective and cheapest disinfectant that has yet been discovered. We take every reasonable precaution to warn consumers of the poisonous nature of carbolic acid, and no accident can possibly occur with the contents of our original packages unless the user is decidedly careless. It is not at all probable that a 'non-poisonous' antiseptic will ever be discovered, as the very act of disinfecting is one of 'poisoning' or killing the numerous living germs which are known to be the propagators of zymotic diseases."

SIXTY-ONE BUSHELS OF WHEAT PER ACRE.

RECENTLY, while traveling through Lancaster County, Pa., we made it a point to visit the farm of Levi W. Groff, near Bareville, in that county. Mr. Groff has been experimenting on the cultivation of wheat; and last year his experiments were so satisfactory (resulting in double the yield heretofore) that this year he has put in thirty acres of wheat, and has it in the highest state of cultivation, having worked it through three times this spring; does not work it in the fall. In cultivating the wheat, Mr. Groff uses a wheat drill six feet between the wheels, and with four sowing tubes instead of eight. Each tube is so arranged with a spreader at the bottom of it as to put the seed in regular rows four inches wide, with nearly eleven inches of space between the rows. The distance between the outside tube and the wheel is the same as between the tubes. This leaves the space between the rows wide enough apart for the horses to walk between them without treading down the wheat. In using the drill for cultivation, the drilling tubes are removed and the three-clawed cultivating hoes are attached—being the same distance apart as the drilling tubes. The claws of the cultivating attachment are in triangular groups, the center one in advance of the two outer ones, which prevents clogging, leaving the ground even and clean. Protectors are also fastened on to prevent the wheat from being covered up by the dirt as it is thrown up by the claws, and they do the work perfectly. We witnessed the operating of the cultivator, and examined its work closely. It leaves the ground fresh, loose and mellow, instead of beaten compactly by the spring rains. The whole thirty acres presented a delightful and pleasing appearance. The wheat looked vigorous, uniform in height, firmly set, rich in color, having that peculiar shade of green which indicates a healthy state of the plant.

We closely compared it with adjoining fields on other farms having equally good soil, equally enriched with fertilizers, and as well put in, but put in with the common drill. It really would not admit of comparison. There was a difference of almost one-half in favor of the cultivated wheat. Mr. Groff informed us that last year he raised sixty-one bushels per acre by his mode of cultivation, being about double the usual yield on that land. The straw is heavier and much less liable to lodge, and the heads and grain grow much larger. A good crop of clover hay had been taken off last fall after the wheat had been harvested, which shows that it does not interfere with the sowing of clover and timothy in the spring; and as good clover we never saw as we did on this farm, following last year's cultivation.

If we were to judge the yield of wheat from the present appearance, we should say that Mr. Groff will be paid many times over for the small amount of extra labor required in cultivation.—*Practical Farmer.*

CRANBERRY CULTURE.

Read before the American Institute Farmers' Club, by J. EDWARD WING.

In presenting this statement of the results of cranberry culture in Eastern Massachusetts to you, I simply give you facts and figures as gleaned from the agent of the Newton Cranberry Bog, which is situated in the town of Barnstable, Barnstable County, Mass.

This piece of swamp land in its original condition was of very little value; the almost only growth upon it was a few stunted pines, low laurel bushes, and an abundance of low green moss, and it was pronounced by an experienced cranberry grower as unfit for cranberry culture, but the results have seemed to prove otherwise.

The bog was prepared in the following manner: 1st. The trees, bushes, and about eight or ten inches of the moss were removed, and the most of that was used to fill low places—was burnt on the bog—then ditches were opened about four or five rods apart, running parallel with each other into the main stream; then, after being made decently level, covering with about two inches of coarse sand or gravel, after which the ground or bog was set with vines, in hills, eighteen inches apart each way. Subjoined I append a statement of the cost of swamp, upland, buildings, etc., together with the expense of preparing the same, and the net returns made to the owners of the cranberry bog, containing a few rods less than sixteen acres, as follows:

Purchased the premises early in the year 1864—

And with the cost of preparing about six acres and setting with vines, paid out	$2,507 66
In the year 1865, four acres, est	2,367 28
In the year 1865, the balance	1,203 31
Total expense paid by owners	$6,103 62

In 1867 the bog was finished, and the expenses of the year for finishing, weeding, etc., were paid from the proceeds of the cranberries raised, and the net amount, free from taxes, which were paid by the agent, divided among the owners each year to date, and the number of barrels harvested, as follows:

In the year.	Barrels.	Over all expenses.
1867	74	$ 12 86
1868	297	1,797 36
1869	391	2,506 72
1870	490	3,953 84
1871	1,258	6,300 16
1872	1,040	8,200 00
1873	1,020½	4,000 00
1874	1,078½	4,400 00
1875	463	1,980 68
1876	859	5,840 00
	6,979	$38,991 62

In 1875 the bog was seriously injured by a late spring frost, and somewhat so in 1876. A fair crop is on it this season, except on about two acres cut off by the vine worm.

In cultivating, the practice has been to clear the weeds and wild stuff from the vines spring and fall, and in summer, when it can be done without much injury to the crop.

By the foregoing simple process much of the unproductive and seemingly worthless land in this country has been brought into profitable cultivation. In other words, the wilderness of stagnant swamps on Cape Cod have been made to blossom and bear fruit, to the joy and satisfaction not only of the cranberry grower, but to all who have the privilege and pleasure of the healthful fruit in its varied preparations for the table.

ATTICA is now a torrid desert for six or seven months every year The lazy, ignorant cultivators burn their wood to fertilize the hills with the ashes, and by May all is parched and pulverized.

BEES.

AN American correspondent writes asking Mr. A. R. Wallace, through *Nature*, his opinion as to the genus *Apis*. Are *dorsata*, *zonata*, *indica*, *adansoni*, *nigro-cincta*, and *florea*, each or all distinct species? or, our correspondent asks, are some of these, like *ligustica* and *fasciata*, simply varieties of *mellifica*? Also as to structure and habits of *A. dorsata* and others, which Mr. Wallace has personally seen and handled.

The following reply has been sent us to these queries:

Mr. Alfred R. Wallace having suggested that I should answer the queries of your American correspondent, I do so at once, having in the year 1865 published in the *Annals and Magazine of Natural History*, a somewhat elaborate paper on the subject on which information is sought for. The species that in my opinion are distinct are *Apis mellifica*, *A. adansoni*, *A. dorsata*, *A. zonata*, *A. unicolor*, *A. indica* and *A. florea*. I do not consider the examination of worker bees only sufficient material to enable any one to form a decisive opinion as to species; the examination of drones, also, I consider indispensable; it is advantageous to see queens, but those which I have seen do not present any very marked peculiarities indicative of specific distinction. I possess males and workers of *A. dorsata*, *A. indica*, and *A. florea*. That *A. ligustica* and *A. fasciata* are climatal varieties of *A. mellifica* has been apparently proved by the fact of their having in England reverted to the original stock, *A. mellifica*; there is, however, a remarkable fact to be noticed—that, notwithstanding the change referred to, they still possess a much greater degree of irascibility than *A. mellifica*; *A. fasciata* undoubtedly in the greatest degree. I consider *A. zonata* distinct from *A. dorsata*, its nearest ally; it is a larger bee, jet-black, with snow-white bands on the abdomen; I have not seen *A. dorsata* from Celebes, where *A. zonata* was discovered by Mr. Wallace, but he found that species in Sumatra, Flores, Timor, and Gilolo. *A. adansoni* and *A. nigro-cincta* will probably prove to be climatal varieties of one species, the latter being a pale form with dark bands. There is no doubt of *A. indica* being a distinct species; all the sexes are known, and there is no other species found in India with which it could be assimilated. Of the specific distinction of *A. florea*, the remarkable structural formation found in the drone, that of a lobe on the metatarsus, is conclusive; it is also much the smallest species known of the genus Apis. *A. unicolor* inhabits Madagascar, Mauritius, and the Island of Rodriguez; a considerable portion of a swarm was obtained from the latter island, an examination of which inclines me to consider the insect much more than a climatal variety of any other species; it remains that the drones and queens should be obtained in order to decide the question; until this can be effected I shall consider *A. unicolor* a good species.

Of the habits of the species of the genus Apis, Mr. Wallace, Sir John Hearsey, Dr. Jerdon, and Mr. Chas. Horne have given some interesting particulars. *A. dorsata* suspends its mass of combs on the branches of trees, quite exposed, having no covering whatever; Sir John Hearsey succeeded in obtaining a swarm which he secured in a box hive, thus domesticating the species, and obtaining from time to time quantities of delicious honey. Dr. Jerdon gave me combs of *A. indica*, which had taken up its abode in the rafters of an outhouse. Mr. Horne gave me the comb of *A. florea*; it is attached to a twig of some bushy plant. Dr. Welwitsch brought combs of *A. adansoni* from Angola; they were found inside a hollow tree; the cells are considerably smaller than those of any of the honey bees of Europe.—FREDERICK SMITH, in *Nature*.

THAT "FATHERLESS AND MOTHERLESS RACE."

THE BASKET-WORM, *alias* DROP-WORM, *alias* BAG-WORM (*Thyridopteryx ephemeraformis*).

By PROF. C. V. RILEY.

I READ with considerable interest the rather amusing but, in many respects, very excellent account of this insect by Mr. William H. Gibson in your SUPPLEMENT, No. 138. He lays himself open to the very charge of mere "mental deduction" which he makes against Dr. Packard and the other authors whom he quotes. He further falls into the same error committed by so many other observers, having no special knowledge of the subject treated. His errors are, however, pardonable, as the question he has been endeavoring to solve was never rightly solved until the year 1869. Had Mr. Gibson ransacked the libraries of the country sufficiently to have met with Vol. II. of the *American Entomologist* (which, by the way, is pretty nearly in every entomological library in the country), he would have found in the number for November, 1869, an article by myself giving a full account of the insect which has so interested and puzzled him, and an explanation of the mode of impregnation. For the benefit of your many readers I will here repeat some of the observations there recorded. Dr. Harris wrote to Edward Doubleday, on the 29th of October, 1849 (*Entomological Correspondence*, p. 179), as follows:

"The males are disclosed in September and the early part of October, and immediately afterward the females will be found to be impregnated. I examined about fifty female follicles on the 25th of October, and found all the females escaped, and their puparia half full of fertilized eggs. It is not true that the females remain in their puparia or in their follicles. Among all those examined as above mentioned not a single female was discovered; they had come out of their pupa skins, and had also left their follicles. It is only at an early period, or, in some rare cases, when the females have remained unimpregnated till this time, that any females are to be found within their pupa skins. But they do not leave their pupa skins until they have been impregnated and have laid their eggs.

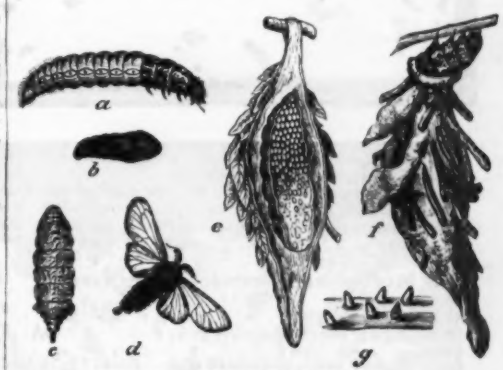
"How the male contrives to get at the female is a mystery that I have not yet solved. The pupa skin of the female splits in the middle of the little carinated ridge found on the top and fore part of the thorax, and also laterally, so as to admit of a kind of T-shaped opening. It is through this that the male organ must be introduced, and, passing between the back skin of the pupa and the body of the female, reach her hinder extremity in the bottom of the pupa skin. But, in addition to this extent to be penetrated, the male has to penetrate the whole length of the lower orifice of the follicle, say half an inch, before he can reach the head of the puparium. The female lays her eggs in the puparium or pupa shell, receding from it as she does so, and filling the shell half or two-thirds full of eggs. The rest of the shell she fills with a fawn-colored down, rubbed off her own body."

In order to elucidate and forever settle these two points in the natural history of our Bag-worm, I closely studied the habits of this insect, and not only examined hundreds of specimens in the open air, but reared great numbers within doors from the egg to the perfect state, watching their operations day by day. The females of several insects which inhabit similar follicles (genera *Œceticus*, *Psyche*, etc.) are perfectly wingless. They are, indeed, the most degraded and imperfect of moths, and afford a marked exception to that very general, but not universal rule, as laid down by Agassiz, viz., that the earliest condition of an animal cannot be its highest. It is well known that certain European species never quit their follicles, and that the shrunken body not only lies near the orifice and protects her eggs, but that it forms the first food of the young larvæ, who play the carnivorous role for the first moments of their lives by subsisting on the remnant of their mother's body. It is consequently stated by most European authors as a characteristic of the group that the females never quit their cases. But as Harris well remarked in the above extract, the insect of which we now write forms an exception to this rule.

The manner in which fertilization takes place is easily explained, though I am not one bit surprised that to Dr. Harris, and to all who have not given close attention to the matter, the *modus operandi* should be involved in such mystery.

The males of most insects mature before the females, but if we take a given number of our Bag-worm cocoons, one-half of which are males and the other half females, and cut them open at the time that the first male makes his appearance from the lot, we shall find that many of the females have already burst open the pupa shell at its anterior or lower end, and have worked themselves through the aforementioned T-shaped opening to the lower end of the follicle. The puparium is held tenaciously to the upper part of the follicle by the abundance of soft but tough silk with which the follicle is lined, but it is extenuated to nearly double its natural length by the efforts which the female makes in emerging. The female never withdraws herself entirely from the pupa shell, but holds on to it by her terminal segments, being evidently assisted by the ring of woolly hair already referred to. Thus, with the pupa shell extended to its utmost capacity, and the additional length of her whole body, she is enabled to reach to the lower orifice of the follicle, where she patiently awaits the male, and, after meeting him, works herself back into the pupa shell. Here she deposits her eggs in the upper part, intermingling them, and crowding the lower part of the puparium with the peculiar fawn-colored down already referred to. After having thus cozily secured her eggs against the winter's blast she works herself out and drops exhausted to the ground.

The eggs are very soft, opaque obovate bodies, about 0·05 in. long, and each is surrounded by more or less of the down which cannot well be detached from it, and seems to be part and parcel of the external surface. The fulvous or fawn-colored down is in reality extruded from the abdomen, and not rubbed off the body as stated by Harris. This fact becomes apparent when we consider the nakedness of the body, and may be proved by dissecting an impregnated female just before the laying of the eggs, or by a microscopic examination of the down itself. It is in reality a very fine silk and not hair. Not only are the eggs mixed with it, and the lower third of the puparium tightly crowded with it, but there is always an abundance of it mixed in with the white silk at the lower end of the follicle, and evidently scattered by the emaciated female in her exit.



THE BASKET WORM.

Follicles in which the female is waiting for the male may be distinguished even without cutting into them, for her body entirely fills up their lower third, which is otherwise contracted and empty. In a state of nature the females scarcely ever fail to get impregnated, but in confinement a majority of them thus fail, and in such an event they remain at the lower part of the follicle until death. Out of 83 female follicles that were set apart by myself in September, 1869, in a separate cage, so that no males could reach them, every one of them died in this manner, and I could not find a single attempt at virginal reproduction, though very closely allied species have been known to produce impregnated eggs without fecundation, and the fact of virginal reproduction mentioned by Mr. Gibson is not remarkable, though it must be looked upon as exceptional.

This Bag-worm is quite polyphagous, occurring on many kinds of deciduous and evergreen trees and even on cotton. Among the few trees which it does not attack may be mentioned the *Ailantus*, and as the Bag-worm often becomes a serious pest in restricted localities, especially in more southern cities, this immunity of the *Ailantus* is a great point in its favor as a shade tree. Two parasites (*Cryptus inquisitor*, Say, and *Hemiteles thyridopteryyis*, Riley) are known to attack it.

The silk which lines the inside of the female case is extremely fine and strong, and could be easily carded and spun. It occurs in tolerable abundance, the quantity varying according to the character of the food-plant. Some experiments which I have been making lead me to believe that this insect which is now a real pest may some day prove valuable as a silk producer.

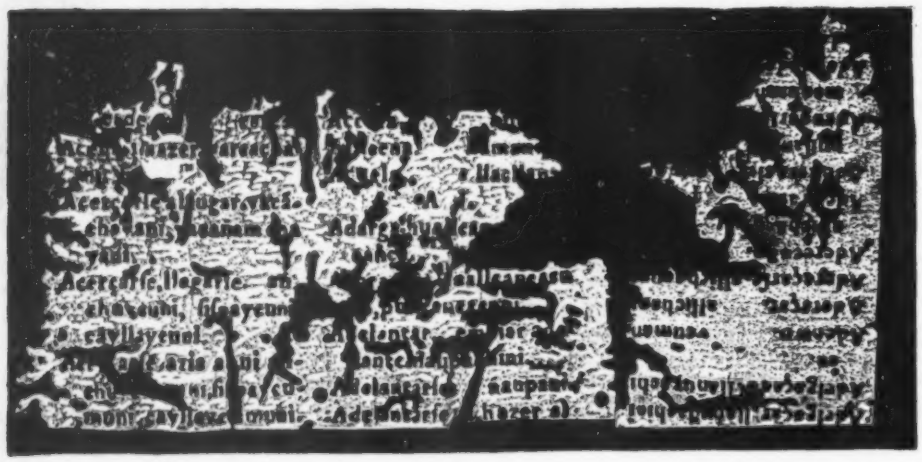
The female being so totally wingless renders the destruction of the pest tolerably easy by cutting off and burning all the cases upon a tree in winter time. It often multiplies so rapidly, however, as to utterly denude small trees, especially cedars and junipers and *Arbor vitæ*. In such case a thorough syringing of the tree with Paris green water, one tablespoonful of pure green to a bucketful of water, proves an effectual remedy, as I have learned from experience.

P. S.—I take the liberty of sending you figures of the insect in its different stages, which will illustrate the gravid female, which Mr. Gibson considers a myth, but which is nevertheless as much a reality as the male.

THE ENEMIES OF BOOKS.

IN our SUPPLEMENT No. 138 we gave several illustrations and a full description of the insect enemies of books; and we now present drawings from old books showing the general character of some of their ravages. One species, the "Sugar Louse" (*Lepisma saccharina*), is very common in almost every house, where it eats holes in silks and silken tapestry, and devours the paste and eats holes in the leaves of books. It has a spindle-shaped body, covered with silvery scales, the sides of the abdomen being furnished with a series of appendages, or false feet, and the tail provided with three bristles pointing outward. Judging from an engraving and description, merely, of the insect, we should say that the Brazilian "Traça" was closely related to our *Lepisma*. The eminent French philologist, Villoison, who was sent by his government to Venice in 1778, in order to search the library of St. Mark for unpublished Greek manuscripts, and who subsequently traveled several years in Greece and the Archipelago, mourns, in his work entitled *Fragments sur la Grèce*, over the fact that he found the libraries in the monasteries at Salonica, Scio, Santorin, Naxos, and even at Constantinople falling literally into dust through the ravages of insects. But however great be the voracity of the insects that have devoured so many precious volumes in the country of Homer, it can scarcely equal, judging from the accounts that we have of it, that of the minute "Traças" above mentioned. These almost imperceptible insects give abundant proof of the activity of their appetites in the curious figures which they trace across the most precious pages of text, converting them in a few days into real lacework, and destroying all semblance of printing to such a degree as to render the pages undecipherable to the most persevering student. It is to these Traças, rather than to handling by students, that is due the destruction of those vocabularies which made known in the sixteenth and seventeenth centuries the elements of the Indian languages; it is to these insects, as much as to the dampness of the old repositories in which they were stored, that is due the disappearance of the records which narrated the deeds of the old *conquistadores* or the stories of intrepid voyagers. Happily some of these old records were copied in former centuries, and the copies taken to Europe. M. Franklin Ramiz Galvam, at present director of the rich national library of Rio de Janeiro, has given a sad description of the difficulties by which the studies of South American savants are beset, through the ravages of the Traça—an insect that he has not been able to destroy. Having enumerated the evils, let us cite such remedies as we know. Unfortunately we no longer possess a knowledge of those heroic methods of treating noxious insects which the old naturalist, Moufet, loves to tell about, while he instances the fact that the garments of Servius Tullius still remained intact from the incursions of the moth after more than five hundred years. The *Bulletin of the Bibliophilist* says that "it is an indisputable fact that the odor of Russia leather is so disagreeable to all insects that naturalists have given a beautiful beetle called the *Trichius* (which possesses this odor to a high degree) the surname of *eremicola*, because other species carefully avoid it. We have had the pleasure of preserving our books, and have attributed it to the care we have taken to keep some of these insects among them as much as possible." A large American *Trichius* (*T. scaber*), often met with, has this same powerful odor of Russia leather to such a degree that its presence may be detected by the scent alone at a distance of two or three yards from its retreat.

Unhappily the numerous insects which are continually feeding on our literary treasures do not all disappear under the influence of *Trichius eremicola*, and there is even some doubt about the efficacy of Russia leather itself, the odor of which it so powerfully exhales. Several insects make their primitive cradle in the paste and glue used by the binder; and from these it is difficult to dislodge the enemy. Many means have been proposed for preventing them from obtaining a lodging in such places; such as mixing alum, colocynth, arsenic, or corrosive sublimate with the paste before using. The learned Namur recommends against such beetles as the "death watches" and "weevils" frequent fumigations of sulphur. But this while killing the perfect beetle has, of course, no effect on their eggs. The perfect insects as well as their larvæ may always be speedily killed when discovered by the application of a little chloroform; and that, too, without any injury to the book. The most efficacious means, however, of preserving a library where there is a large collection of books is to look them all over quite frequently and beat them out.



FRAGMENTS OF OLD SPANISH BOOKS IN THE LIBRARY OF RIO DE JANEIRO DESTROYED BY THE TRACA.

THE INTELLIGENCE OF ANTS.

AT the meeting of the British Association in Dublin, on Aug. 16, Sir John Lubbock read a paper on "The Habits of Ants." A great desire to hear it was expressed, and the reading of it was frequently interrupted by the efforts of a crowd of disappointed people to get into the room, which was complained of as too small.

Sir John Lubbock stated that he had been for some years watching the habits of ants, and had kept under observation about thirty species. Though living in captivity, they were in good health, and he had in one nest a queen which had lived with him since 1874. He could confirm the statements which had been made with respect to the architectural skill of ants, their attention to their young, their remarkable organization, their possession of domestic animals, and even the institution of slavery. He had also watched several other insects which lived in association with them, of which M. André calculated that there were 583 species. In some cases the association was accidental, in others it was because the nests afforded shelter to other insects, and there were also some uncomfortable companions which attached themselves to ants, and could not be got rid of.

The common house ant was to be found sometimes in association with other ants, but the cases were exceptional, and he had never seen any instance. A nearly allied species, however, the sanguinea, was sometimes found in association with others, generally the fusca. In such cases the nest belonged to the sanguinea. The queen and the young were of that species, and the fuscas were slaves, though free to come and go, as there was no fugitive slave law, and they seemed to be quite reconciled to their position. They assisted in the household duties, and in foraging for provisions. They kept the aphides in corn, and derived a considerable share of their sustenance from them. In the winter, when they were of no use, they were still tended with great care, until the spring, when they became again useful, an instance of prudence and forethought unexampled in the animal kingdom. There was one species which took no part whatever in the duties of the household, and would even starve in the midst of plenty if the food were not put into their mouths. He had confirmed Huber's remarkable experiments on this point, and had kept some alive and in health for months by allowing them a slave for an hour a day to feed and clean them.

To test their intelligence he suspended some honey about half an inch over the nest, which could only be reached by a paper bridge ten feet long. He then made a small heap of earth by which they could reach it. They soon swarmed over the earth and began to eat, but when he removed some of the earth it never occurred to them to heap it up again, though they tried to stretch up to the honey, and they went round by the bridge. He made a similar experiment by placing honey which could only be reached by crossing a chasm over which he had laid as a bridge a bit of straw. He slightly moved the bridge, and they tried in vain to stretch over, but never thought of putting the straw back, which they could easily have done. Every one knew that if an ant or a bee found a store of honey others would soon collect about it; but very little intelligence was implied if the ants and bees only accompanied their friends.

The case was different if they could describe the locality and send their friends to it. They did not, however, appear to be able to communicate as much as that to their friends. If a fusca's nest were disturbed and one of them found a place of concealment, she was anxious that her friends should come to it. She went up to one of them and took it by the mandible. The second ant rolled herself up into a ball, and was carried over her shoulder to the place. The second ant then went to a third, and the process was repeated. He put an ant which had been without food for some days to honey, and saw that after feeding she was on her way to the nest when she met some friends, whom she fed, and then returned alone to the honey. On her way back she met some other friends, whom she fed, and then five of them went back with her to the honey. In due course they, no doubt, brought others.

He believed they were able to distinguish between a large and a small quantity. To test this, he put some of the Lasius Niger species into a small store, and others into a large one, and having watched for fifty hours, found that the ants with the small quantity brought 82 friends to share it, and the ants with the large store brought 257. To try whether they could send their friends to a store, he put an ant (Niger) to some honey, which he placed near her nest. She fed, returned to the nest, and came out with ten friends. He took her up, however, and put her into the honey, and her friends then wandered about, and then returned to the nest. It was hard to say whether there were differences of character in ants of the same species, as they behaved differently under different conditions; but there were great differences of character and habits between those of different species, putting aside the slave-making species, which he thought would find it impossible to compete with the self-dependent and freer species. These communities even showed curious analogies to the earlier stages of human progress.

There were the hunting, the pastoral, and even the agricultural ants. The first lived chiefly by the chase, and hunted alone. Their battles were single combats, like those described by the ancient poets. The second were a higher type of social life. They demonstrated certain species of aphides like flocks and herds. They were immense and acted in concert. He thought they would probably exterminate the first type, just as the white man exterminated the savages. Of the agricultural class—the harvest ants—he would not speak, as there were none in this country. When he first began to keep ants he isolated the nests by water, but it was necessary to change that often, and observing that the hairs on the stems of flowers prevented the ants from climbing them, he had since used ferns. One of the most surprising points connected with ants was that while there was one nest they never appeared to quarrel, all others, even of the same species, being treated as strangers and enemies. There was no mistaking the treatment. If an ant (*fusca*) wanted to carry away a friend to a place of security, she took her by the mandible, and her friend rolled herself into a ball, but an enemy is seized by the leg or an antenna.

He confirmed the experiments of Huber as to their being able to recognize their friends, even after a long absence, or rather their acquaintances, for although he saw they attacked and killed their enemies, he could not find any trace of warm affection for their friends. He tested this by taking some out of a nest and suspending them in a bottle covered with muslin. Those in the nest took no notice of them, but when strangers were put in they were indignant, and never stopped until they cut through the muslin and attacked them. He marked some ants in a nest with paint, and found that their friends removed it, but a stranger going into the nest was restless, and got out as quickly as possible. It would be interesting to know how they recognize their friends. It might be by smell or some sign, or by actual recognition.

In order to try whether they could recognize them when insensible, he first used chloroform; but that practically killed them, and he then made them intoxicated. He did so by putting them into whisky, not whisky into them, for they were too sensible to take it even on week days. He tried an experiment with twenty-five friends and thirty strangers. The sober ants coming out of the nests and finding the intoxicated ants lying helpless on their backs in ludicrous attitudes, proceeded to take them up and carry them off. Of the twenty-five they brought twenty into the nest, where, probably, they soon slept off the effects. The other five they dropped into the moat of water which then surrounded the nest. Why they did so he could not tell. Perhaps they fell into the hands of stern teetotalers. As to the thirty strangers, twenty-eight were thrown into the moat, and the other two were taken no notice of.

He took some pupæ out of a nest, and on putting them back, after some months, found that they were received as friends, while some which were put into a different nest were attacked. It was generally stated that all the eggs in a nest of ants or bees were laid by queens. That was not strictly so, for some were laid by workers, though the cases were exceptional. He had some nests in which there were no queens, and yet there were eggs in them; but the eggs laid by workers always produced males. He had made some experiments to test the senses of ants. He found that they were capable of distinguishing between different colors, and avoided velvet. Their sense of smell was also delicate, but he had seen no proof that they were capable of hearing, and he had proved by an experiment, which he described, that they were not capable of communicating with each other by sound. There were thirty species of ants in these countries, and 700 in other countries, and there were many interesting problems to be solved in relation to them.

Sir Walter Elliott asked how ants communicated with each other, and mentioned that on one occasion in India, when making a preparation of a spider, an ant approached and attempted to carry off the specimen. He drove it away, and then five others came, and having occasion to leave the room, he found on his return that the specimen was gone.

The President observed that perhaps in tropical regions the ants were more civilized, and possessed a power of communicating with each other which was not enjoyed by ants elsewhere.—*London Times.*